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BIRD CONTROL PROBLEM AND BIRD STRIKE ANALYSIS OF CZECH AND SLOVAK AIRPORTS

Summary. This article deals with the problem of bird control at airports in both the Czech and Slovak Republic. The result of so-called bird strike (aircraft/bird collision) can cause serious damage to the aircraft and even lead to the crash. The article focuses on the whole range of procedures used to prevent collision of birds with aircraft at these airports. Moreover, the statistical research of bird strikes reported at the Czech and Slovak airports is provided. Hence, the suitability of exploited procedures is assessed based on the data research. At the airports where birds strike figures are intolerable, the proposal of recommended procedures is introduced in order to improve safety of particular airport operations.

PROBLEMY KONTROLI PTAKÓW ORAZ ANALIZA ZDERZEŃ Z PTAKAMI NA LOTNISKACH CZECH I SŁOWACJI

Streszczenie. Ten artykuł zmaga się z problemami kontroli ptaków na lotniskach zarówno Czech jak i Słowacji. Rezultat tzw. ptasich zderzeń (kolizji samolot/ptaki) może powodować poważne uszkodzenia samolotu a nawet doprowadzić do jego rozbicia. Artykuł skupia się na całości procedur używanych do prewencji kolizji ptaków z samolotami na tych lotniskach. Ponadto badania statystyczne zgłoszeń zderzeń z ptakami na lotniska Czech i Słowacji są zapewnione. W związku z tym, przydatność wykorzystywanych procedur jest oparta na badanych danych. Na lotniskach gdzie liczba zderzeń z ptakami jest nie do przyjęcia, propozycja rekomendowanych procedur jest przedstawiona by umocnić bezpieczeństwo poszczególnych operacji lotniskowych.

1. INTRODUCTION

As the air transport continues to grow, the number of aircraft movements increases continuously. A great number of flights are performed in low altitudes by general aviation, military aviation and by commercial aircraft on landing and take-off. Moreover, the aircraft speed increases as well.

On the other hand, the atmosphere is a natural habitat for birds. They had been occurring there long ago the human race started to using the atmosphere as an environment for one of the transport modes. For the last more than 100 years, mankind is interfering with the birds in their native habitat. Most birds fly at less than 300 meters above the ground.

At the very beginning of aviation, the low speed of flight made it possible for the birds to avoid a collision. Also, the force of any collision was small. In most cases a collision resulted in minor

damage to wind shields and leading edges of wings or the fuselage. The probability of collision was also small because of the small number of aircraft.

Most of the birds quickly became used to the noise and speed of propeller aircraft and learnt to stay away from the dangerous airspace in the vicinity of the airport. The situation changed in the fifties after turbo-prop aircraft and jet aircraft were introduced. This increased the speed of flight, the aircraft's acceleration and their dimensions. Therefore it was more difficult for the birds to avoid the flying aircraft and the impact force of a collision was greatly increased. The rate of collisions was also increased by the large quantity of air sucked into the jet engine and large dimensions of the engine intake. The jet engine also proved to be less resistant than piston engines to collision with the birds. Moreover, modern aircraft are quieter and therefore it is easier for them to escape the attention of the birds [1-5].

It is therefore evident that bird strikes are a serious hazard for aircraft.

2. BIRD STRIKE CONSEQUENCES

The consequences of mutual collision between the bird and the aircraft depend on the following variables. They can be described by the equation:

$$m \cdot v = F \cdot t \tag{1}$$

where m is the bird mass; v is the velocity of collision; F is the force of bird strike and t is the collision time. In other word, the resultant force depends on the bird mass and the velocity of collision:

$$F = m \cdot \frac{v}{t} \tag{2}$$

When talking about m (the bird mass), the range in weight starts at the tens of grams and ends at the tens of kilograms. A goose weights about 3 kilograms, a stork up to 5 kilograms and a pelican more than 10 kilograms.

As it was explained in the introduction, the aircraft speed increased after the jet aircraft came in operation. Hence, the velocity of bird/aircraft collision increased as well. Considering the take-off and approach speed of jet aircraft and the bird velocity, the v can count as much as 100 $m.s^{-1}$.

As for the time of collision, it counts in hundredths of second, most commonly 0.03 s.

When filling the equation (2) with the data $m = 10\ kg$; $v = 100\ m.s^{-1}$ and $t = 0.03\ s$, the resultant force will be:

$$F = 10 \cdot \frac{100}{0{,}03}\left[kg \cdot m \cdot s^{-2}\right] \tag{3}$$

$$F = 33{,}3kN$$

On the top of this force, it is necessary to add that most birds are flying in flocks. That means the force needs to be multiplied by number of birds in the flock. Hence, the result of such interaction can have serious impact on the safety of a particular flight. The example of bird strike result can be seen at Fig. 1.

The cost to an airline as a consequence of damage to an aircraft after a bird strike can reach millions of euros. It is not only the price for the repairs of the aircraft but also the costs in connection with taking the aircraft out of service, redirecting passengers and freight to other flights and the costs for accommodation and board of the passengers. Delay of the aircraft or its temporary withdrawal from service has a domino effect on the timetable of airline and all connecting flights. It can cause a substantial increase in operational costs and blemishes the good reputation of the airline.

On the other hand, the cost to airports in preventing collision of birds with aircraft is also not negligible. For instance, on New York's J.F. Kennedy airport they exceed half million dollars a year, which is approximately the price of repairing two engines on a Boeing 747 aircraft.

Fig. 1. Aircraft damage caused by bird strike (Source: photoblog.nbcnews.com)
Rys. 1. Zniszczenia samolotów spowodowane przez zderzenia z ptakami (Źródło: photoblog.nbcnews.com)

3. BIRD CONTROL AT CZECH AND SLOVAK AIRPORTS

The size of the bird strike problem is different at each airport. In order to prevent bird strikes effectively in the vicinity of airports it is necessary to have an in-depth understanding of the customs and behaviour of the birds. It is therefore important for the airport administration to cooperate with ornithologists.

However, there are international regulations dealing with bird control problem. The most important document is ICAO DOC 9137 – *Wildlife Control and Reduction* followed by International Bird Strike Committee's *Standards for Aerodrome Bird/Wildlife Control*. Airport procedures should follow these rules with regard to local conditions.

In order to investigate the particular local procedures utilised at Czech and Slovak airports, the collection of particular documentation must be accomplished. Since these documents are not publicly accessible, the visits and consultations had to take place at most of the international airports in two selected countries. After all, the documentation from six airports was collected; two Czech and four Slovak airports:

- Prague airport is the biggest airport in the Czech and Slovak Republic in terms of both aircraft movements and passengers handled.
- Brno airport is a no. 3 airport in the Czech Republic in terms of passengers handled, right after the Prague and Ostrava airports.
- Bratislava airport is a major airport in the Slovak Republic with huge portion of international traffic.
- Piešťany airport is regional airport utilised by general aviation. There is no regular route at an airport.
- Žilina airport is regional airport without regular route. It serves mainly for training purposes.
- Sliač airport has both military and civil traffic. There is no regular route but significant amount of charter flights are operated during the summer season.

Measures used to mitigate the bird threat can be divided into two categories; (1) preventive (or passive) and (2) active methods. Both are used at all investigated airports.

3.1. Preventive methods

Preventive methods are associated with habitat management, which include the maintenance of grass areas. The ideal grass height is about 20 cm or more. Only a few species of birds like pheasants and partridges prefer long grass, whereas most birds rest on short grass or they search for food in it. If the grass is higher than 20 cm, the view of the birds is limited and they cannot move easily in the grass. In order to avoid frequent grass cutting and also to make it less attractive, there are special grass mixes, which grow up to the height of around 20 cm and in addition to this, they contain particularly

sharp and thorny blades. At all selected airports but one, this height is ensured. The only exception is the Brno airport where the higher grass areas are kept around the airport as a catchment area. These areas serve as a shelter for birds and lower the probability of birds penetrating onto shorter grass areas, which cover the surroundings of runway and taxiways.

Another sort of passive methods is effort to communicate with owners and users of land in the vicinity of an airport. Since the legal rules do not oblige the owners to cooperate with airport authorities, the communication can be sometimes difficult. Bright example is the Žilina airport where the hunting in cooperation with local hunting authorities is organised in order to reduce the number of birds on regular basis.

3.2. Active methods

The second type of measures, active, is used to scare and disperse the birds away from the airport field. Even if the airports are trying to make themselves unattractive for birds by changing the habitat (passive measures), a flock can fly onto the airport and sit on the runway at any time. The sporadic appearance of birds at the airport must then be controlled by scaring them off. The flock of birds must be scared and dispersed as soon as possible, because a flock of birds on the ground attracts other birds of the same kind and the flock gets bigger. Also, it is easier to disperse a small flock than a big one. The easiest way is to scare the birds before they settle down on the airport.

At selected airports, various techniques are used such as acoustic (shooting) or natural enemy technique (falconry, hunting dog). Utilization of particular bird control techniques at investigated airports can be found in Tab. 1. There are also modern techniques like RC model scaring, built-in loudspeakers with remote control etc. but none of these are use at investigated airports.

Table 1

Bird control techniques (active) at selected airports

	Shooting	***Hunting dog***	***Falconry***	***Vehicle***	***Horse***
Prague	✓	✓	✓	✓	✓
Brno	✓	✓	✓	✓	✓
Bratislava	✓	✓	✓	✓	×
Piešťany	✓	×	×	✓	×
Žilina	✓	×	×	✓	×
Sliač	✓	✓	✓	✓	×

Shooting is the most common technique at all selected airports. Shells from shotguns and various pyrotechnical projectiles from gas guns are used so that birds are not killed, only scared. Particular pyrotechnical shell is used based on the bird kind to be dispersed. These projectiles create both visual and acoustical effects.

For birds settled onto the airport areas, hunting dogs are used at Prague, Brno, Bratislava and Sliač airports. The dog must be well trained and can be used for scaring rabbits, foxes and deer as well.

The most sophisticated and effective active method is falconry. Birds of prey are used at Prague, Brno, Bratislava and Sliač airports. Most common bird of prey is peregrine falcon, which costs about 200 – 300 euros. Bigger species are much more expensive and hence less used. However, the Prague airport uses eagles and Brno airport Harris hawks. Falconry is demanding from both personnel and financial requirements. Birds of prey have to be trained on daily basis.

Moreover, the bird control staff needs to be mobile so that vehicles are used at all selected airports. In Czech Republic, the staff mobility is approached more complexly. In addition to cars, there are horses kept at Prague and Brno airports. This ensures more flexibility when moving on the unpaved surfaces.

Bird scaring methods vary in their effectiveness depending on the situation. Some techniques can be used only sparingly, because the birds get used to them. It is often advantageous to combine the techniques or to change the intensity of use. Continual scaring can, none-the-less, significantly reduce the number of birds in the airport.

4. BIRD STRIKE ANALYSIS AT SELECTED AIRPORTS

4.1. Methodology

The procedures described in the previous chapter may or may not be effective enough in terms of local conditions. In order to determine whether the procedures are effective or not, the following method will be applied.

There is an internationally standardized way how to measure the bird strike rate at given airport. It is based on ICAO International Bird Strike Committee manuals [6, 7]. The rate *number of bird strikes per 10 000 aircraft movements* is set. Therefor it is inevitable to gain data about the aircraft movements from selected airport and the bird strike numbers. The first is no problem as these data are publicly accessible from the airports' annuals reports. The second is not publicly available and this data was gained from the particular departments within investigated airports thanks to author's personal visits and consultations.

According to the bird strike rate per 10 000 movements, the coefficient is determined. Hence, the airport falls into particular ICAO bird strike risk probability category. Categories are shown in Tab. 2.

Table 2

Bird strike risk probability categories

Coefficient	0 – 0.2	0.3 – 0.9	1 – 2.9	3 – 10	10 and more
Probability category	Very low	Low	Medium	High	Very high

4.2. Dataset

The bird strike figures and aircraft movement numbers from five airports in Czech and Slovak Republic was gained. The dataset covers the five-year period, from 2007 to 2011. The only exception is Brno airport where the bird strike data from two years only (2010 and 2011) was provided.

As it can be seen from the Tab. 3, the crisis at the end of the 2008 hit both major airports Prague and Bratislava. From that point the traffic started to decline (one year later in Brno as well). On the other hand, airports without international traffic (Piešťany) or with very low international traffic (Žilina had one route to Prague; until 2010) did not register any decline due to crisis (Žilina's decline caused by cancelling the only regular route).

Table 3

Aircraft movements at selected airports from 2007 to 2011

	2007	***2008***	***2009***	***2010***	***2011***
Prague	174 662	178 628	163 939	156 167	146 612
Brno	22 983	29 303	30 513	25 027	26 837
Bratislava	31 599	34 873	29 481	27 220	25 358
Piešťany	1 248	1 896	2 780	3 324	5 936
Žilina	10 971	12 673	14 232	15 190	7 484

Tab. 4 shows the numbers of bird strikes reported at investigated airports.

Table 4

Bird strike figures at selected airports from 2007 to 2011

	2007	*2008*	*2009*	*2010*	*2011*
Prague	42	50	46	48	42
Brno	N/A	N/A	N/A	3	7
Bratislava	28	34	23	30	33
Piešťany	0	0	0	0	0
Žilina	0	1	0	0	0

The figures from Tab. 4 are of crucial importance for the analysis conducted in the following subsection. The correlation between amount of traffic and bird strike numbers is evident – there are only few collisions reported from airports with lower traffic (Brno, Piešťany, Žilina airports).

4.3. Analysis results

Even if the used methodology is very simple, it reflects international standards. The figures from Tab. 5 were computed by dividing the number of bird strikes by number of movements (in tens of thousands). The Piešťany airport had not reported any bird strike within the examined period hence the coefficient is zero. Very similar case is Žilina airport with only one bird strike reported within the five-year period (collision of pilot training aircraft with stork). Third case, Brno airport, provided only two bird strike figures. The resulting coefficients are 1.2 and 2.6 collision per 10 000 aircraft movements for the years 2010 and 2011 respectively. Standard deviation is as much as 0.7 in this case.

However, the data from both major airports within particular countries, Prague and Bratislava, are much more comprehensive. Let us start with Prague airport. The figures are pretty constant – ranging from 2.4 as a minimum in 2007 to 3.1 as a maximum in 2010. That means the standard deviation equal to 0.23. This is a sign of constant level of safety at this airport.

On the other hand, the bird strike figures per 10 000 movements are three to four time higher at Bratislava airport compared to the Prague case. The minimum (7.8 collisions per 10 000 movements) was achieved in the 2009. On contrary, the maximum of 13 bird strikes per 10 000 movements was reported in the 2011 which is the absolute maximum among investigated airports. The growing trend is evident. In this case, standard deviation is as much as 1.8.

Table 5

Bird strike per 10 000 movements at selected airports from 2007 to 2011

	2007	*2008*	*2009*	*2010*	*2011*
Prague	2.4	2.8	2.8	3.1	2.9
Brno	N/A	N/A	N/A	1.2	2.6
Bratislava	8.9	9.8	7.8	11	13
Piešťany	0	0	0	0	0
Žilina	0	0.8	0	0	0

Tab. 6 brings the assessment of bird strike risk probability at selected airports. The smallest airports in terms of traffic volume, Piešťany and Žilina, have *very low* probability of bird strike occurrence (one appearance of *low* assessment is negligible as it was caused by a single collision). Brno airport is ranked with *medium* bird strike risk probability in both years when data was available. The same can be concluded about the Prague airport with all but one year of *medium* risk probability. As the standard deviation in this case was the lowest among all five airports, the one rating of *high* assessment is considered as negligible.

The most alarming case is the Bratislava airport. The assessment of bird strike occurrence is *high* or *very high* in each year within the tracked period. This may be a sign of insufficient approach to the bird control problem. Proposals will be made in the next section.

Table 6

Bird strike risk probability at selected airports from 2007 to 2011

	2007	***2008***	***2009***	***2010***	***2011***
Prague	Medium	Medium	Medium	High	Medium
Brno	N/A	N/A	N/A	Medium	Medium
Bratislava	High	High	High	Very high	Very high
Piešťany	Very low	Very low	Very low	Very low	Very low
Žilina	Very low	Low	Very low	Very low	Very low

5. BIRD CONTROL PROCEDURES ASSESMENT AND PROPOSAL OF MEASUREMENTS TO MITIGATE THE BIRD STRIKE RISK PROBABILITY

Among the selected airports, there are three of them where the bird strike figures are in the tolerable sector (collision risk probability up to *medium*) – Brno airport, Piešťany airport and Žilina airport. We can conclude that the current procedures are sufficient and effective.

5.1. Prague airport

In the Prague airport case, one could conclude the same [10]. But the closer look reveals that the coefficients from particular years are at the upper limit of the *medium* risk category. Moreover, in the 2010, the high risk category was identified. In spite of that, we can conclude that the current procedures could be subject to revision. Even if the one appearance of *high* risk probability was considered as negligible, a few improvements will be proposed as an addition to the existing ones.

Given the fact that all years but one were classified as a *medium* risk probability, there is no need to propose active measures. Active measures need to be implemented when the *high* risk probability is identified. This is not the case, hence only passive, preventive measures are proposed.

The first point is training for personnel conducting bird control at the Prague airport. This training should include:

- learning to identify all bird kinds occurring in the vicinity of an airport as well as getting to know with their habits, behaviour and main attractants,
- preparation of habitat management plan,
- information about particular scaring techniques and their correct usage,
- responsibility allocation among particular staff,
- practical training in terrain.

The second recommendation is to create plan of preventive measures, which should contain:

- schedule and technique of grass surfaces mowing,
- identification of critical farm crops,
- schedule of agricultural works in the vicinity of an airport,
- reducing nesting possibilities.

5.2. Bratislava airport

As far as Bratislava airport, the figures from both Tab. 5 and Tab. 6 cannot be considered as tolerable. The airport is predetermined for the above average presence of birds. There is a city with the huge community of pigeons in the vicinity of airport. Moreover, the Malý Dunaj River lies near the runway 13/31 threshold. And finally, there are migration corridors above the airport land. All those factors lead to the enormous amount of birds in this location. Therefore the following measures are proposed in order to get the bird threat under control.

Since there are *high* and *very high* risk assessments of all examined years, both active and passive measures will be proposed in this case. As for the later, passive, there has to be clear arrangement

between airport and landowners in the vicinity of an airport. Every owner has to be aware of duties arising from location in so-called ornithological protection zones. Following those duties must be supervised by an airport on a regular basis. This land should be used to cultivating those kinds of agricultural products that are not too attractive for birds. Agricultural work schedule should be agreed by an airport authority and adjusted to the airport operation in particular season. Any works without airport approval should be prohibited. Increasing awareness and negotiating consensus should be the primary goal of an airport authority in relation to the land users within the ornithological protection zones.

There are certain active methods used at the Bratislava airport in order to mitigate the bird threat. However, those need to be supplemented by other ones. Besides conventional pistol shells, the gas gun with special pyrotechnical projectile should be used more often. There is wide supply of projectiles, each dedicated to scare particular kind of birds. During the flight of projectile, it glitters or smokes and when combined with shells, the scaring effectiveness will be significantly increased. For dispersion of bird flocks settling on the ground, the pyrotechnical bombs should be utilized. They are more intense in terms of noise and can cover larger area.

If presented active and preventive measures will not succeed and the bird threat will not be mitigated, the automatic scaring devices must be considered as a possible solution. Even if they are expensive, they could significantly improve the situation when combined with currently used techniques. Those systems could be both acoustical (loudspeaker) and pyrotechnical and controlled remotely.

What is of crucial importance is an appropriate material supply and sufficient staff number. In terms of this issue, the proposal is to ensure:

- at least three staff members dedicated to bird control during daylight,
- at least one staff member dedicated to bird control during night time,
- a bird of prey and hunting dog for each staff member,
- two vehicles for the bird control station,
- each vehicle equipped with acoustic and optical beacons,
- own shotgun, gas pistol and sufficient number of shells for each staff member.

6. CONCLUSION

Bird control is a crucial element of airport safety system. Bird strike can cause serious damage to an aircraft and even lead to the crash. On top of that, damaged or destroyed aircraft brings significant costs to an airline. Regardless of any financial consequences, the most precious asset – human life – must be protected at any time and any conditions. Especially in aviation, the safest transport mode. Therefore, it is inevitable to pay close attention to mitigating bird hazard.

In order to do that, there are many international regulations dealing with bird control problem. Every airport should follow these rules. All selected airports do that as well. However, the effect varies from case to case. Some airports are located at the areas predetermined to significant bird occurrence. But using the right procedures and their combinations, also significant bird presence can be kept within safe limits.

Small airports with only general aviation operations (Piešťany airport, Žilina airport) do not record high number of bird strikes even if they are located in bird friendly environment, Žilina airport especially. This is a sign of mature and effective bird control. As the traffic grows (Brno airport, Prague airport), the bird strike figures rise as well but still within the safe limits. The bird strike risk probability at these two airports is at medium level, which is tolerable according to the international rules and recommendations. However, there is an airport with high/very high bird strike risk probability among investigated airports. Bratislava airport is an example of location attractive for birds. Various bird control methods are used but they are not effective enough. Hence, it is necessary to consider implementation of new ones, even if they might be costly. However, any costs spent in order to increase sufficient level of safety are costs spent wisely.

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