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STATISTICAL ANALYSIS OF GROUND-RELATED INCIDENTS AT AIRPORTS

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Abstract

In recent years, the aviation sector has been developing dynamically. The constant increase in the number of passengers contributes to an escalation in the number of air operations. This trend is mainly due to the increased traffic not only in airspace but also within airports. The large concentration of aircraft at the largest airports makes ground-flying phases such as taxiing or take-off becoming a challenge for pilots, ground services, and air traffic controllers. An intensive operation of many objects on the airport's manoeuvring areas can lead to collisions between them. Global air traffic is growing constantly, with record numbers of air operations and passengers carried. The probability of a collision increases, which leads not only to the cancellation of the flight but also to the significant costs of the aircrafts repair. The statistical analysis allows to highlight the problems related to the issue of ground collisions at airports and can also confirm the thesis concerning the growth and density of air traffic.

Keywords: *air transport, statistical analysis, airports incidents*

1. Introduction

The most crowded area at the airport is the apron. It is a very dynamic environment, in which planes simultaneously move out of the parking places and out after the flight. It is used for loading, refuelling and boarding of passengers. The planes are located close to each other, one next to the other, which means that manoeuvring the planes is significantly restricted. It ought to be noted that an equally busy, and often congested, airport area are taxiways, where many aircraft are taxiing at the same time.

2. The most common incidents scenarios

In most cases, pilots of circling aircraft are aware of the presence of an impending obstacle, an example of which is a standing aircraft, but they do not assess adequately the distance between them. The areas that are most likely to be damaged are the following: wing ends, wingtip devices, vertical and horizontal stabilizers and elevators. In many types of aircraft, pilots have limited visibility of the wing ends due to the specific arrangement of the windows in the cockpit.

The collision between the two planes takes place mainly in the vicinity of crossings or forked taxiways. Then one of the machines catches the wing or tail of the other one. The three most common collision scenarios between the taxing aircrafts are shown in Fig. 1.

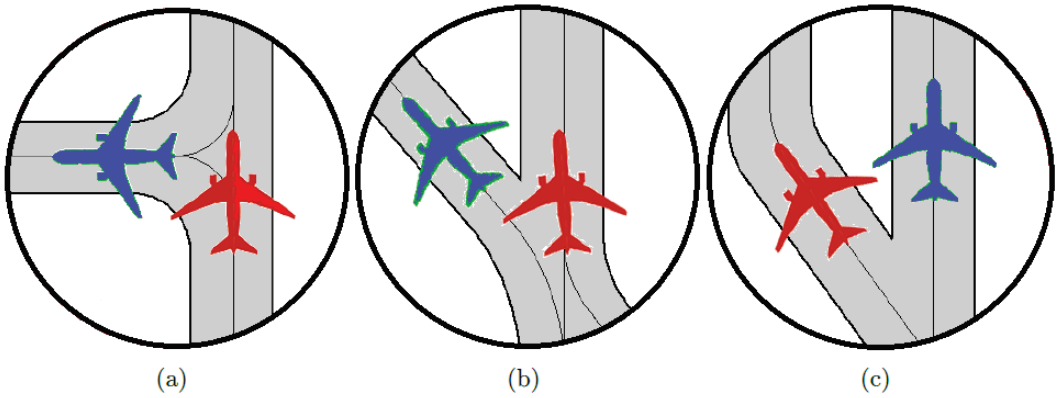


Fig. 1. The three most common collision scenarios between a taxing aircraft (red) and another one (blue)

3. Air traffic at airports

Air traffic in the world is growing constantly, reaching record levels in terms of the number of air operations and passengers carried. An excellent example could be Schiphol Airport in Amsterdam, where the number of arriving and departing aircraft is 1000 per day and increasing year by year, reaching the capacity limits [1]. Also the world fleet of both passenger and cargo aircraft has increased since 2009 from 1,750 to nearly 32,000 aircraft in 2018 [2]. Such a trend results in an increase in traffic congestion at the airport, which means that aircraft rotation at airports must be as high as possible, which means that aircraft downtimes (unloading and loading times) are reduced to a minimum and taxiing speeds are increased to a maximum [3, 1]. The American airline Southwest has reduced the average downtime of its aircraft from 50 minutes up to 35 minutes [4].

Such a dynamic causes more and more pressure on crews and ground workers. The likelihood of a collision increases, which leads not only to the cancellation of the flight but also to significant costs for the repair of the aircraft. Due to events and incidents in the airport manoeuvring areas, the world aviation market is losing around $11 billion. Tab. 1 shows the type of ground collision that occurs most often and which part of the costs is taken up by the air budget.

Tab. 1. Part and percentage of collision costs with respect to the collision type [5]

Collision type	Percentage of collision	Percentage of costs
Aircraft – Service equipment	80%	16%
Aircraft – Aircraft	10%	56%
Aircraft – Object	10%	28%

Despite the fact that 80% of the incidents are caused by collisions between aircraft and service equipment, about 84% of the costs out of $11 billion are caused by collisions between aircraft and other aircraft as well as stationary objects.

4. Statistical analysis of ground-related incidents

The statistical analysis allows to visualize the problems related to the subject of ground collisions at airports and may confirm the arguments regarding the growth and congestion of air traffic. Data from www.airlive.net and aviation-safety.net were used for this purpose. Descriptive statistics were selected as the research method for incident analysis. The whole analysis, due to the limited data on ground events, covers the events that took place at world airports in the period 01.2012 – 10.2017 and applies to commercial air transport aircraft.

The number of passengers increases every year, which translates into an increase in the number of flights and aircraft operated at airports. Traffic congestion is also associated with a higher risk of any unplanned events, such as ground collisions. In the years of 2012-2017, there were 242 collisions, where the year with the highest number is 2017. The trend of the occurrence of the event is clearly increasing and comparing the year 2012 with 2017 the increase of collision on the ground is equal to 200% (Fig. 2).

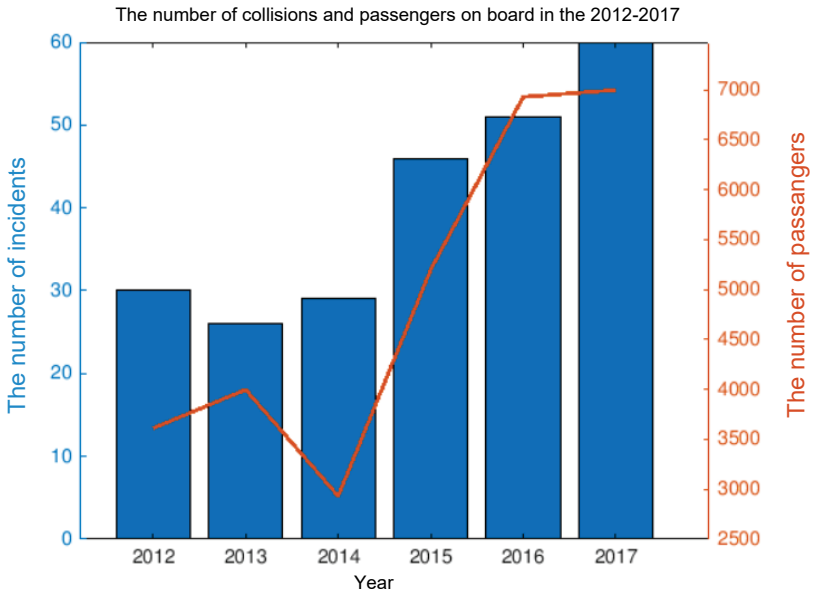


Fig. 2. The number of collisions and passengers on board in the 2012-2017

The number of travellers is growing rapidly, reaching 7,000 passengers in 2017, which gives an average of 117 passengers on board in 60 planes.

In order to check whether the major part of aircraft in the ground incident is caused by the medium-size aircraft, the size of the aircraft involved has been taken into account. The aircrafts were divided into 6 classes in according to [6]. The basic and main criterion for the division was the wingspan, as shown in Tab.

The analysis is based on data for class B-F aircraft; class A aircraft are assigned to small aircraft that are generally rare used for commercial flights. The distribution of aircraft collisions number by size is illustrated in Fig. 3.

Nearly 60% of the incidents are attributed to Class C aircraft. A large percentage of these aircraft are also of class E, which may be the result of the presence of such aircraft at the world's largest airports, such as London's Heathrow and New York's JFK. It is worth mentioning that the E-type machines are slowly replacing the largest aircrafts of class F.

Tab. 2. Aircraft classification [6]

Aircraft class	Wingspan [m]	Examples of aircraft
A	<15	TBM-850, PA-34, Cessna Citation
B	15-24	ATR-42, ATR-72, CRJ-200/700, Saab 340
C	24-36	A319, A320, A321, B737, DHC-8, ERJ-170/195
D	36-52	A310, B757, B767, DC-10
E	52-65	A330, A340, A350, B777, B787, B747-4, MD-11
F	65-80	A380, B747-8

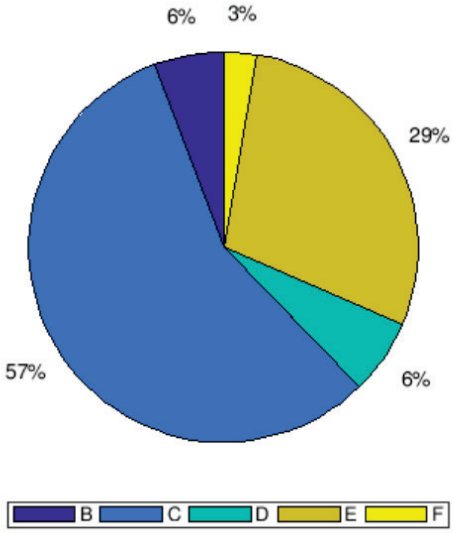


Fig. 3. The distribution of aircraft collisions number by size

North America is the continent on which most air operations are carried out. It accounted for 35% of all events on the continents. In second place is Europe with 64 collisions, which is 25% of all events. This distribution is shown in Fig. 4.

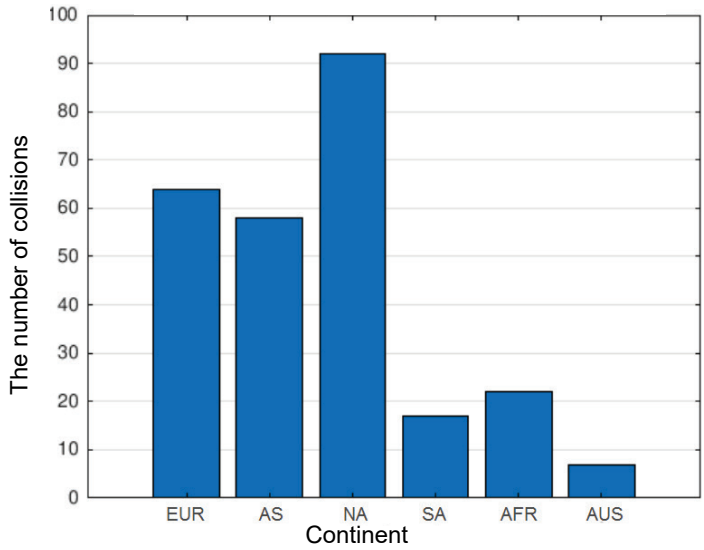


Fig. 4. The distribution of the number of ground-level events that took place on the continents between 2012 and 2017

At an airport, objects can be divided into stationary and mobile. Distances to stationary objects are usually long, which is due to the design of airports, and collisions with them occur most often when the crew enters the wrong taxiway or ignores the horizontal signs of the airport. The percentage of is shown in Fig. 5.

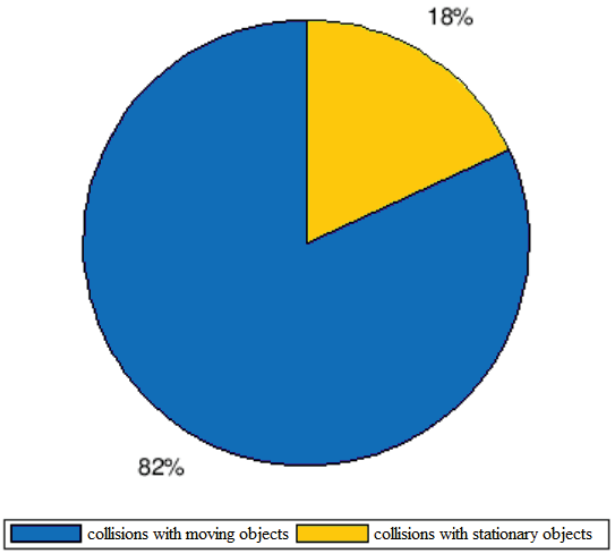
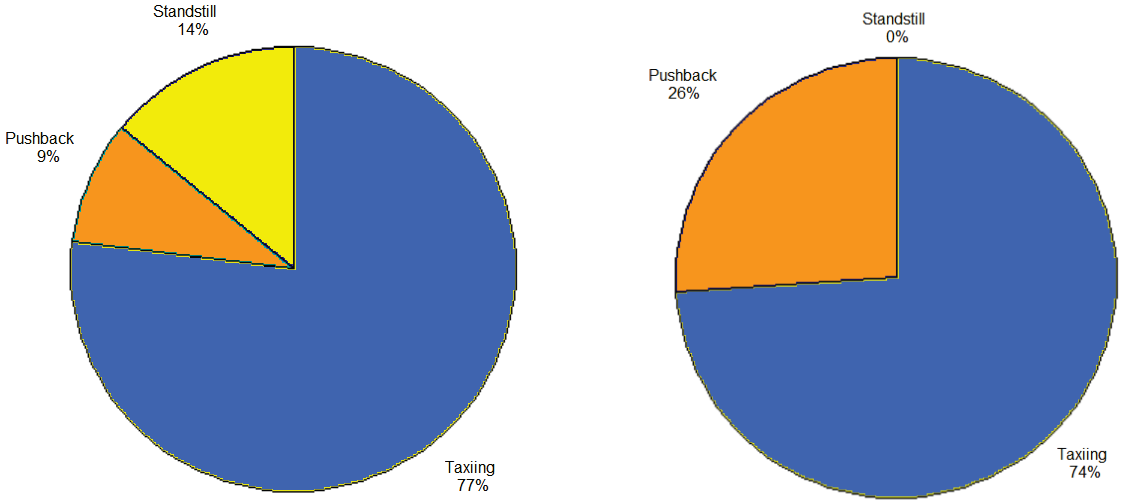


Fig. 5. The percentage of collisions with moving and stationary objects

Moving objects, mainly airplanes, most frequently move on taxiways, which results in the largest number of ground collisions occurring during the taxiing phase. This may be due, among other things, to the large concentration of air traffic, which is manoeuvring in various directions. Collisions and situations close to collisions in ground flight phases are shown in Fig. 6.



(a) Collisions *(b) Situations close to collisions*

Fig. 6. Collisions and situations close to collisions in ground flight phases

The lowest percentage of collision is attributed to the pushback stage, during which the aircraft is driven by a pushback. Nearly a quarter of the events took place on the airport apron, where the phases of standstill and pushback take place. The situation is almost the same in the case of an almost accident threatening situation during which an event has nearly occurred.

5. Conclusions

Ground collisions from the point of view of air carriers lead to serious implications, which are primarily associated with significant costs. According to Flight Safety Foundation, the aviation industry loses an average of $11 million every year due to events and incidents on airport manoeuvring areas [7]. This type of event takes place mainly in large airports, where the concentration of aircraft traffic is very high [4]. The result of ground collisions, often in spite of small and seemingly harmless damage, is that the aircraft is taken out of service for a few days or even weeks. This time is intended for a thorough inspection and repair of the relevant components. Repairing is not only time-consuming, but is also very expensive.

Although the physical damage to the aircraft in ground collisions is much smaller and less significant than in other incidents, the consequences are similar – delays or cancellations, inconvenience to passengers and their nervousness [8]. It has been calculated that the delay costs $57 per minute for American carriers, and the cost of cancelling a flight often exceeds $150,000. Such a price includes, among others, lost incomes and the need to provide accommodation for passengers [9].

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