EVACUATION OF AIRCRAFT ON LAND

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Abstract:

Introduction/Purpose: Aircraft present one of the safest and most frequently used means of transport. However, despite taking many security measures, accidents happen. No matter a damage level, if the aircraft somehow manages to land, the most important is to evacuate passengers from the aircraft, fast and safely. Evacuation of aircraft is very complex and depends on many different factors such as a damage degree, presence of fire, speed of passengers, presence of panic and fear, etc. So, it is important to, somehow, as much as possible, predict potential ways of evacuation and potential evacuation strategies and routes. Landed aircraft can be in different conditions so fast and safe evacuation of passengers is very important. The only way to predict safe evacuation routes, to determine proper evacuation strategies and to calculate potential evacuation times needed to leave the aircraft is to use some adequate simulation software.

Methods: In this paper, for calculating needed evacuation times and potential evacuation routes, the simulation method was used. Simulations of evacuation scenarios and calculations of evacuation times were realized in Pathfinder software. The simulation model created in Pathfinder was a model of the A 321 aircraft related to its real dimensions.

Results: The results of this paper, obtained on an appropriate simulation model of the aircraft with stairs and emergency slides, have shown the evacuation times for two different evacuation scenarios with different speeds of passengers/occupants.

Conclusion: A proper evacuation strategy and the fastest evacuation of occupants are crucial for saving lives. Simulation software use in evacuation problems presents a very effective way in terms of safety, cost-effectiveness and prediction. This kind of software presents an obligatory engineering tool for more effective and more precise dealing with evacuation and similar problems. This paper was written to show how simulation software can be used for calculating evacuation times from an airplane on land.

Key words: evacuation, aircraft, simulation, passenger.

Introduction

Evacuation of people, animals and material resources from endangered places or buildings to a safe location in a fast and safe way always presents a complex task.

Generally, traffic presents a very important social activity where potential situations and occasions demand very effective evacuation strategies. According to reports and statistics, air traffic presents one of the safest ways of traffic. Most accidents in air traffic occurred in the air during taking off and landing. A diagram of all accidents in civil air traffic from 1919 till October 1921 is presented in Figure 1 (Planecrach, 2021).

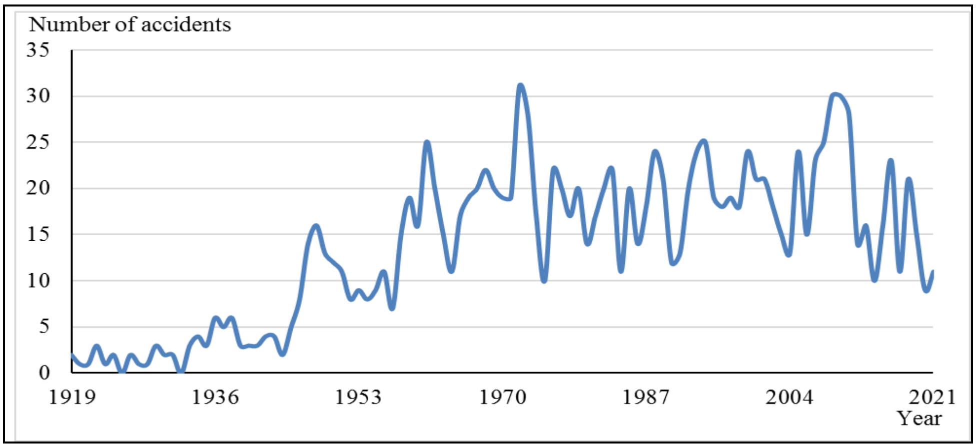

Figure 1 – Aircraft accidents from 1919 till October 2021
Рис. 1 – Авиакатастрофы с 1919 по октябрь 2021 год
Слика 1 – Авионске несреће од 1919. до октобра 2021. године

One of the most important advantages for air traffic in terms of safety are rigid procedures and rules for aircraft and high scientific and quality levels used in manufacturing aircraft. But accidents do occur. Sometimes, it is possible to avoid accidents or to reduce consequences of accidents. Of course, the most important course of action in any case of damage, malfunction or any problem, is to land the aircraft immediately. Many accidents were avoided by forced landings, very often out of the runway. A well-known case called „Miracle on the Hudson flight“ occurred in January 15, 2009, when a commercial airplane landed on the Hudson river and all 155 passengers and the crew members survived (CN Traveler, 2022). However, even when an aircraft somehow lands, a very important moment is to evacuate the passengers from the airplane to the safety. Potential scenarios can be different: an engine failure while taking off, missed runway while landing, wheals failure while taking off or landing, outing of the runway, etc. This task can be very hard, depending on many factors. In many cases, passengers try to evacuate the aircraft without any kind of organisation, tactics or plans; the presence of fear and panic is huge and injuries and even deaths are very likely to happen. Also, very often, the cabin crew do not have precise and continual connection and communication both between themselves and with the passengers which implies a delayed or considerably longer evacuation. The fact that the aircraft must be evacuated immediately is disturbing enough in its own right, but in the presence of other phenomena such as fire, smoke, sparking, etc., the whole situation becomes extremely tense and likelihood for accidents significantly increases. Generally, evacuation from a landed aircraft can be realized by emergency exits which can be equipped with stairs, emergency slides and emergence ropes (SKY Bary, 2022).

Therefore, for safe and effective evacuation, it is very important to know which evacuation strategy to apply in different situations: in which direction to go, which exit to choose, how fast to go in order to avoid the jams and crowds, etc. In a situation such as force landing or a bomb threat, these tasks can be very hard to realise because of the presence of many different factors such as fear, stress, panic, lack of time, etc. It would be thus best to somehow predict as many potential scenarios as possible and calculate potential evacuation times. All of this is possible with the use of simulation software. So, this paper was written to show the advantages of simulation software use in the prediction of evacuation. The main motive and the aim of evacuation is to save human lives. The most important advantages of simulation software use are to calculate times needed for evacuation from aircraft in different situations and scenarios and predict a lot of potential situations and scenarios in a safe, inexpensive and effective way. The number of all potential scenarios is huge and it is almost impossible to predict all potential scenarios, but with use of simulation software a lot of scenarios can be realized and analysed so that the knowledge and results gained in that way generally significantly improve a degree and efficiency of evacuation. The main contribution of this work is in prediction - in determining the best evacuation scenarios for occupants in some real situations by using simulation software. The use of the simulation software method for predicting evacuation is still a novelty and a method not used enough for determining evacuation scenarios and calculating evacuation times. The use of simulation software is safe for human lives because real occupants are not involved. It is also very cost-effective because it does not require the use of different material resources. And, of course, it is very precise because simulation software uses checked algorithms for calculations with the influences of many different factors (speed of occupants, stairs dimensions, number of occupants, etc.).

Pathfinder simulation software

The main method used in this paper was the simulation method. Although computer-based simulations have been used in last 20-25 years, it is still a method not often used (Galea et al, 1998). Simulation is possible by the use of proper simulation software, called Pathfinder software, version 2021. There are very important reasons for simulation software use in evacuation. Safety is above all. It would be almost impossible in reality to design and test evacuation scenarios without accidents and even victims and material resources destruction. Then comes accuracy. The software of this kind shows a great degree in precision and accuracy. In addition, the time needed for calculating the whole simulation is significantly shorter than the time needed for a simulation without simulation software.

This powerful simulation software provides simulations of people moving along various passageways such as stairs, elevators, or ramps with different speeds of occupants. There are two different simulation modes: a so-called SFPE mode and a steering mode. One of very important characteristics of this software is to „import“ files from other programs which significantly increases the compete simulation process because in that case it is not necessary to draw the environment (Thunderhead, 2017; Jevtić, 2021).

Simulation model

The aircraft simulation model was designed in the Pathfinder simulation software based on the aircraft real dimensions. The simulated aircraft was A 321. There are different versions of this aircraft. The simulated version was based on the following dimensions: overall length 44.51 m, cabin length 34.44 m, maximum seating places 220, fuselage width 3.95 m, maximum cabin width 3.7 m and wing span 35.8 m. The complete interior was designed to imitate the real aircraft (seats, compartments, etc.). The complete number of persons/occupants in the aircraft was 228. This number also included three members of the pilot crew and five members of the flight attendant crew (Airbus Aircraft, 2022).

The evacuation from the aircraft was simulated with two different scenarios: using ordinary stairs for passengers and using emergency slides. For the first scenario, there were three different simulations realized: with one front door opened, with two doors opened (the front and the back ones) and with three doors opened. All used doors in simulations for this scenario were on the same side of the aircraft. Although there are four doors on both sides of the aircraft, in real situations at airports, mostly one or two entry/exit doors with stairs are used. The speeds of passengers/occupants were 0.2 m/s, 0.3 m/s, 0.4 m/s, 0.5 m/s, 0.75 m/s, 0.95 m/s and 1.15 m/s. These speeds were chosen because of the lack of space in the aircraft for bigger speeds and the existence of seats and a narrow aisle in the middle of the aircraft.

For the second scenario, there were eight different cases simulated. The first case involved all eight doors opened; the second case involved one door closed and seven doors opened; the third case involved two doors closed and six doors opened; the fourth case involved three doors closed and five doors opened; the fifth case involved four doors closed and four doors opened; the sixth case involved five doors closed and three doors opened; the seventh case involved six doors closed and two doors opened, and the eighth case involved seven doors closed and one door opened. For each of seven cases, the emergency slides were used. The speeds of passengers/occupants were 0.2 m/s, 0.3 m/s, 0.4 m/s, 0.5 m/s, 0.75 m/s, 0.95 m/s and 1.15 m/s in the plane, while the emergency slide speed was 1 m/s.

The first case involved $\binom{8}{0}$=1 possibility for every speed of passengers/occupants. The second case involved $\binom{8}{1}$=8 different possibilities for every speed of passengers/occupants. The third case involved $\binom{8}{2}$=28 different possibilities for every speed of passengers/occupants. The fourth case involved $\binom{8}{3}$=56 different possibilities for every speed of passengers/occupants. The fifth case involved $\binom{8}{4}$=70 different possibilities for every speed of passengers/occupants. The sixth case involved $\binom{8}{5}$=56 different possibilities for every speed of passengers/occupants. The seventh case involved $\binom{8}{6}$=28 different possibilities for every speed of passengers/occupants. The eighth case involved $\binom{8}{7}$=8 different possibilities for every speed of passengers/occupants. The doors with emergency slides were marked with numbers from 1 to 8. The exit doors also have the same marks.

The simulation model of the A 321 aircraft with its interior is presented in Figure 2 in Pathfinder software while the emergency slides of the aircraft marked with numbers from 1 to 8 are presented in Figure 3. Many details in figures could be visible if the HIDE function were not activated.

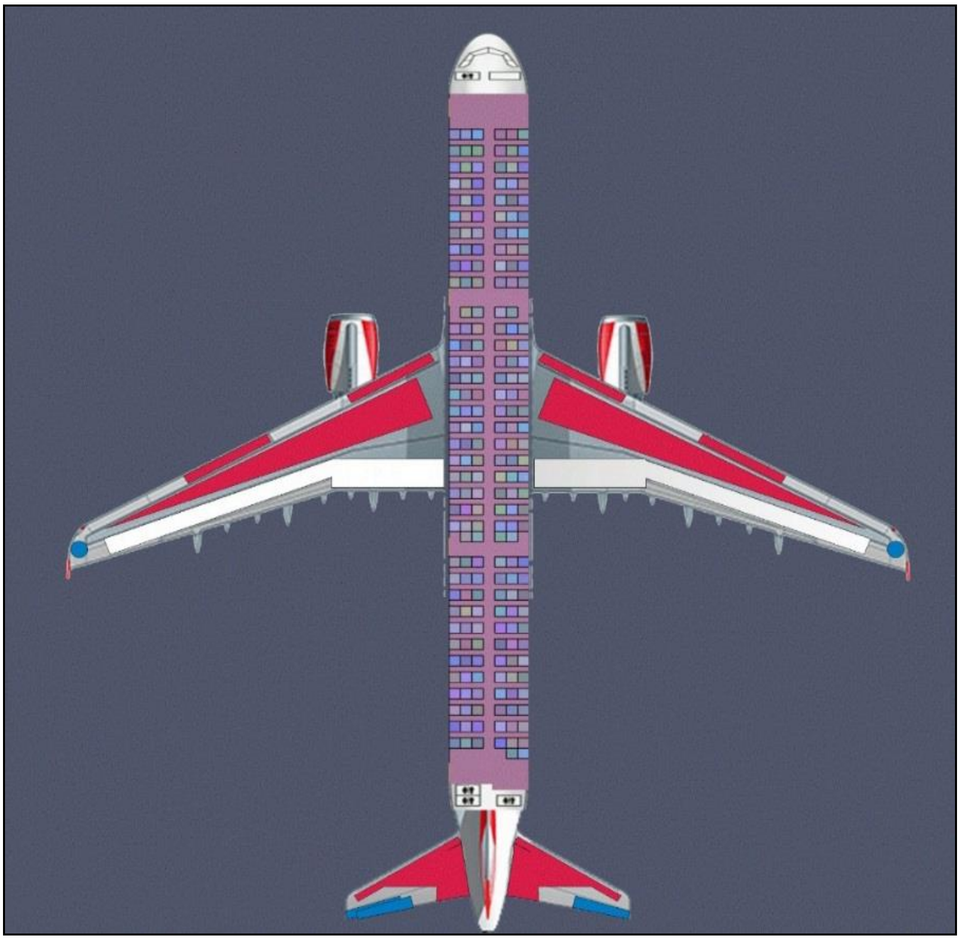

Figure 2 – The simulation model of the A 321 aircraft with its interior, Pathfinder presentation
Рис. 2 – Имитационная модель самолета А 321 с его интерьером, презентация Pathfinder
Слика 2 – Симулациони модел авиона А 321 са унутрашњошћу у презентацији Pathfinder

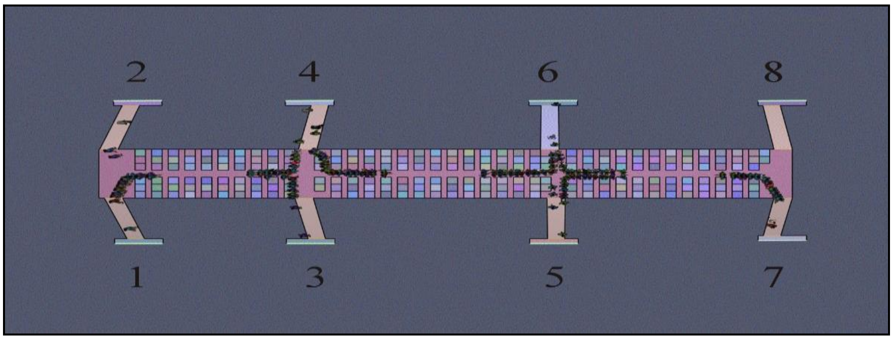

Figure 3 – Emergency slides of the aircraft marked with numbers from 1 to 8
Рис. 3 – Аварийные выходы самолета обозначены цифрами от 1 до 8
Слика 3 – Излази у случају евакуације из авиона, означени бројевима од 1 до 8

Simulation results

All simulation results for this paper were realized on a laptop Dell Latitude, with Intel® Core™ i7-1185G7 (4 Core, 12M cache, base 3.0GHz, up to 4.8GHz, vPro) processor and 16 GB of RAM memory. It is recommended to use a computer with „strong“ hardware support for work with simulations.

Some simulation moments are presented in Figures from 4 to 7, while the simulation results are given in Figures 8 to 25.

Because of a huge number of realised simulations and the paper limitations, only the results for the fastest and the slowest possibilities for every case of the second scenario were presented.

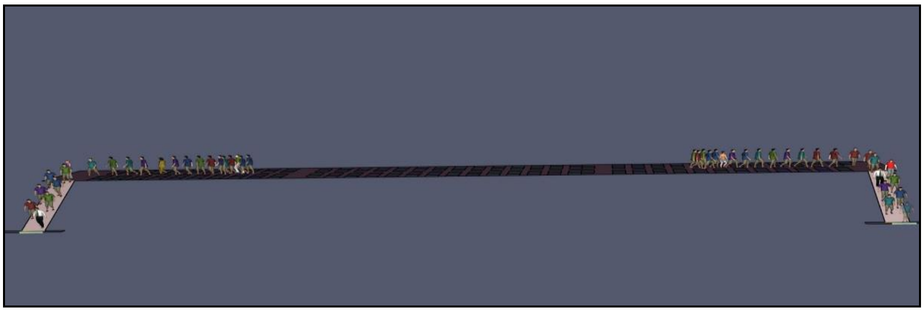

Figure 4 – Simulation moment for the second case of the first scenario at 170 seconds after the start of the simulation
Рис. 4 – Момент имитации другого случая по первому сценарию через 170 секунд после начала имитации
Слика 4 – Тренутак симулације за други случај првог сценарија после 170 секунди од почетка симулације

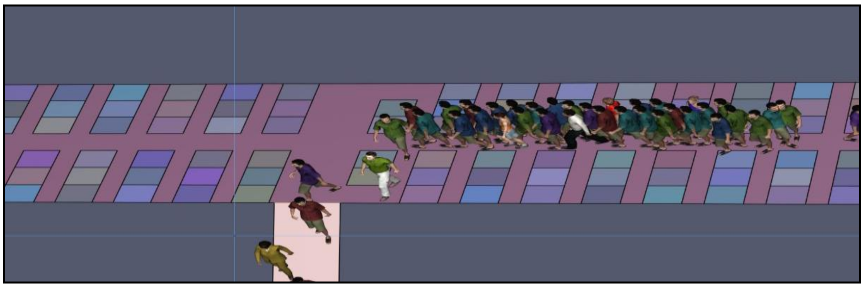

Figure 5 – Simulation moment for the third case of the first scenario at 88 seconds after the start of the simulation
Рис. 5 – Момент имитации третьего случая по первому сценарию через 88 секунд после начала имитации
Слика 5 – Тренутак симулације за трећи случај првог сценарија после 88 секунди од почетка симулације

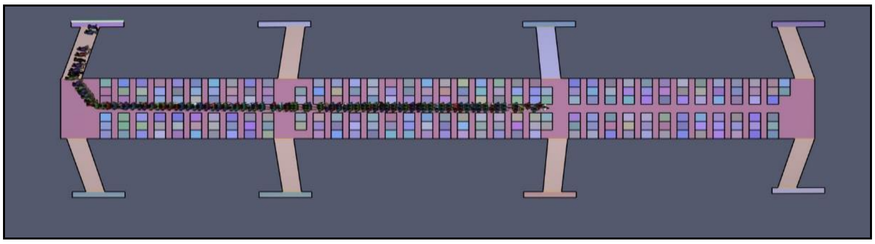

Figure 6 – Simulation moment for the seventh case of the second scenario after 130 seconds after the start of the simulation
Рис. 6 – Момент имитации седьмого случая по второму сценарию через 130 секунд после начала имитации
Слика 6 – Тренутак симулације за седми случај другог сценарија после 130 секунди од почетка симулације

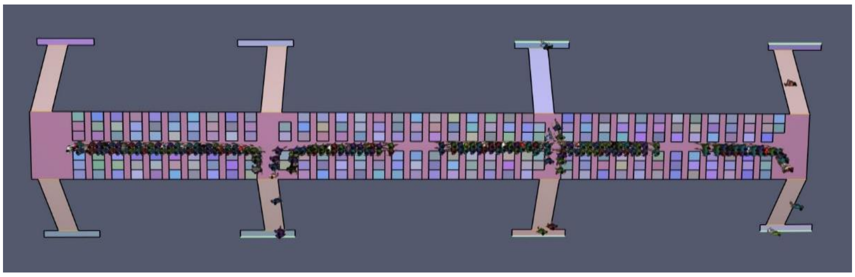

Figure 7 – Simulation moment for the fourth case of the second scenario after 28 seconds after the start of the simulation
Рис. 7 – Момент имитации четвертого случая по второму сценарию через 28 секунд после начала имитации
Слика 7 –Тренутак симулације за четврти случај другог сценарија после 28 секунди од почетка симулације

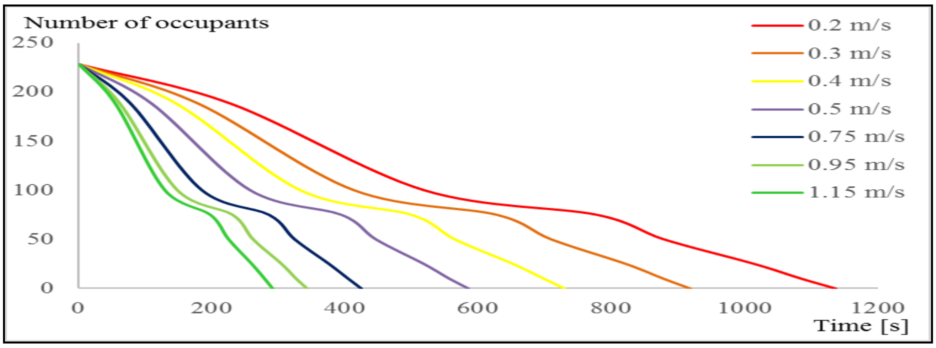

Figure 8 – Simulation results for the first case of the first scenario
Рис. 8 – Результаты моделирования первого случая по первому сценарию
Слика 8 – Симулациони резултати за први случај првог сценарија

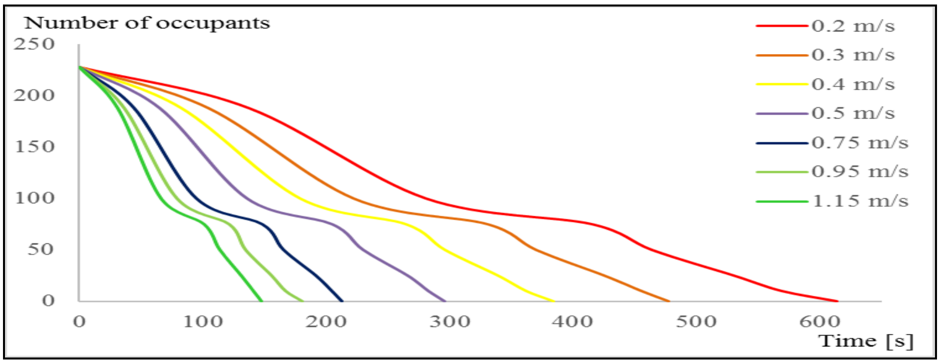

Figure 9 – Simulation results for the second case of the first scenario
Рис. 9 – Результаты моделирования второго случая по первому сценарию
Слика 9 – Симулациони резултати за други случај првог сценарија

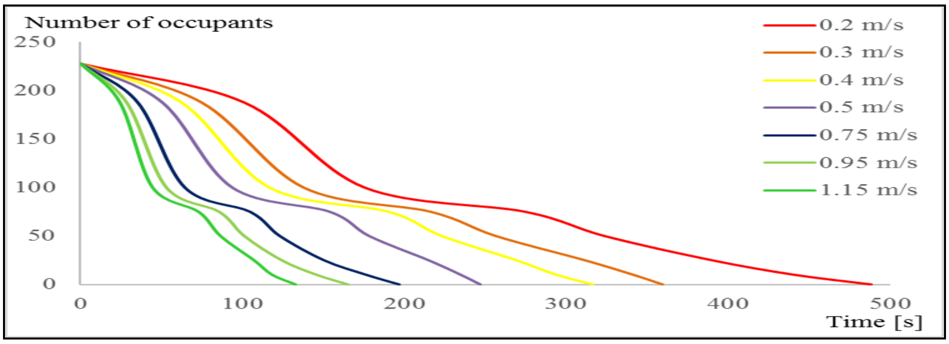

Figure 10 – Simulation results for the third case of the first scenario
Рис. 10 – Результаты моделирования третьего случая по первому сценарию
Слика 10 – Симулациони резултати за трећи случај првог сценарија

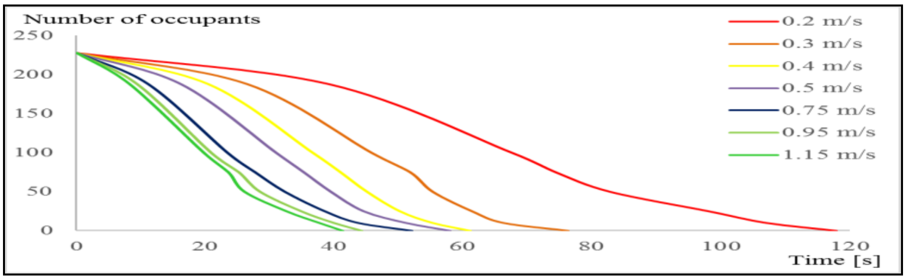

Figure 11 – Simulation results for the first case of the second scenario
Рис. 11 – Результаты моделирования первого случая по второму сценарию
Слика 11 – Симулациони резултати за први случај другог сценарија

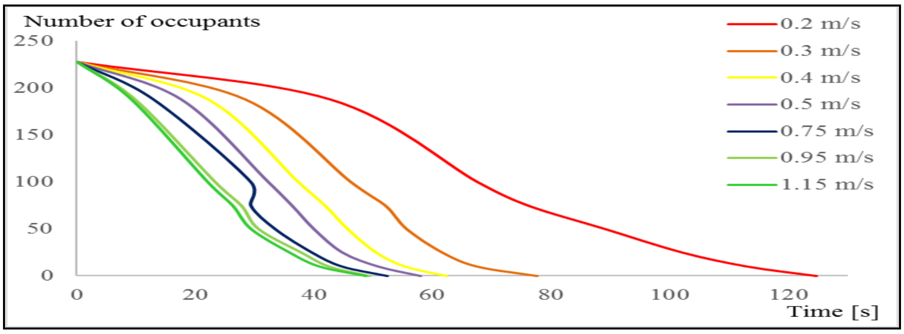

Figure 12 – Simulation results for the fastest times of the second case of the second scenario
Рис. 12 – Результаты моделирования скорейшего времени второго случая по второму сценарию
Слика 12 – Симулациони резултати за најбржа времена другог случаја другог сценарија

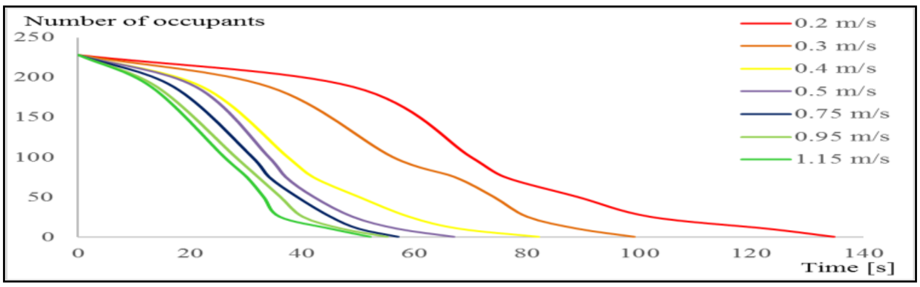

Figure 13 – Simulation results for the slowest times of the second case of the second scenario
Рис. 13 – Результаты моделирования самого медленного времени второго случая по второму сценарию
Слика 13 – Симулациони резултати за најспорија времена другог случаја другог сценарија

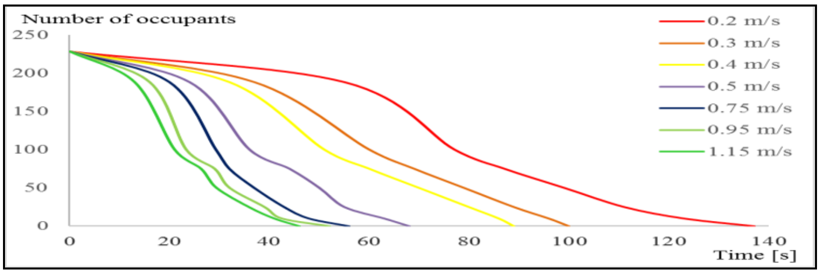

Figure 14 – Simulation results for the fastest times of the third case of the second scenario
Рис. 14 – Результаты моделирования скорейшего времени третьего случая по второму сценарию
Слика 14 – Симулациони резултати за најбржа времена трећег случаја другог сценарија

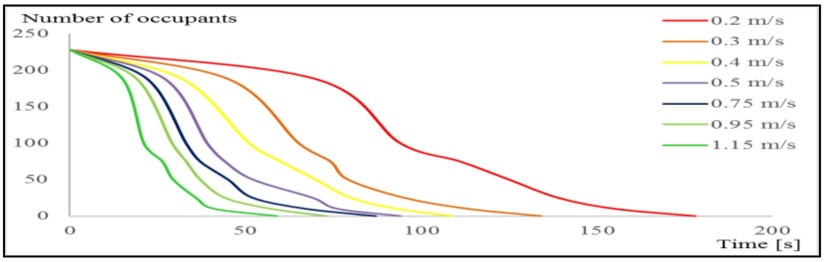

Figure 15 – Simulation results for the slowest times of the third case of the second scenario
Рис. 15 – Результаты моделирования самого медленного времени второго случая по второму сценарию
Слика 15 – Симулациони резултати за најспорија времена другог случаја другог сценарија

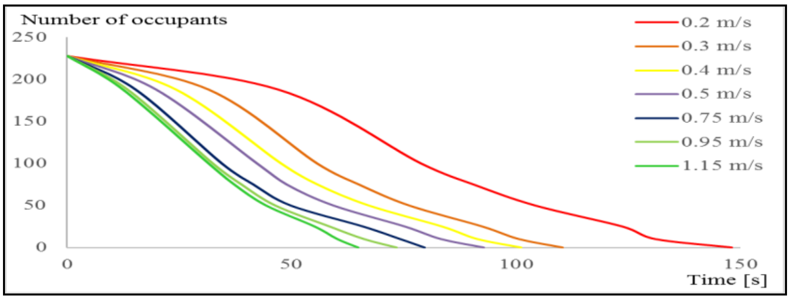

Figure 16 – Simulation results for the fastest times of the fourth case of the second scenario
Рис. 16 – Результаты моделирования скорейшего времени четвертого случая по второму сценарию
Слика 16 – Симулациони резултати за најбржа времена четвртог случаја другог сценарија

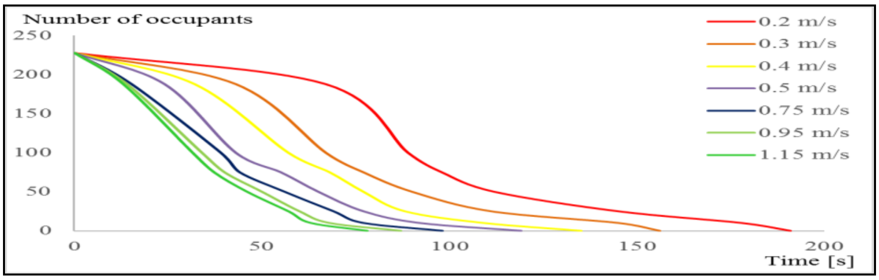

Figure 17 – Simulation results for the slowest times of the fourth case of the second scenario
Рис. 17 – Результаты моделирования самого медленного времени четвертого случая по второму сценарию
Слика 17 – Симулациони резултати за најспорија времена четвртог случаја другог сценарија

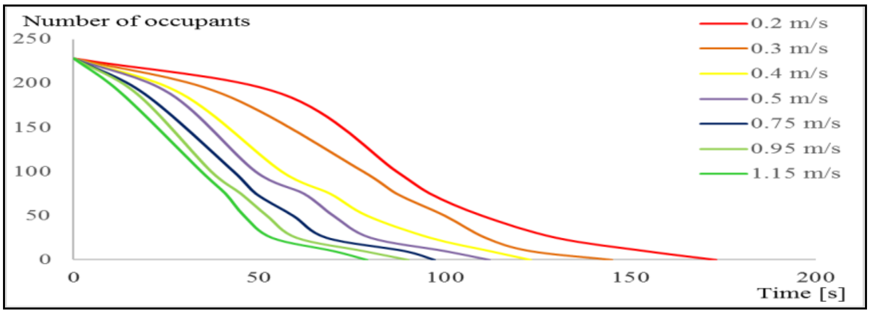

Figure 18 – Simulation results for the fastest times of the fifth case of the second scenario
Рис. 18 – Результаты моделирования скорейшего времени пятого случая по второму сценарию
Слика 18 – Симулациони резултати за најбржа времена петог случаја другог сценарија

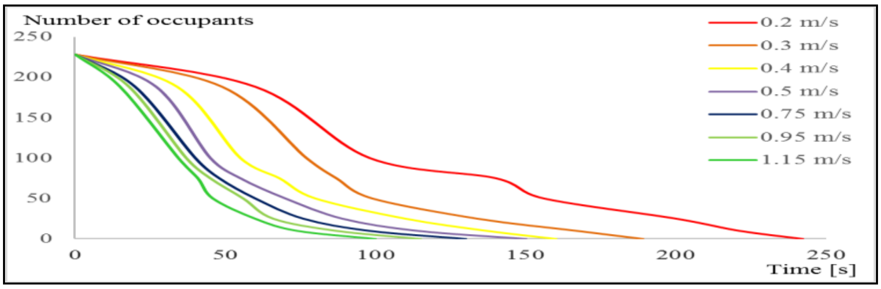

Figure 19 – Simulation results for the slowest times of the fifth case of the second scenario
Рис. 19 – Результаты моделирования самого медленного времени пятого случая по второму сценарию
Слика 19 – Симулациони резултати за најспорија времена петог случаја другог сценарија

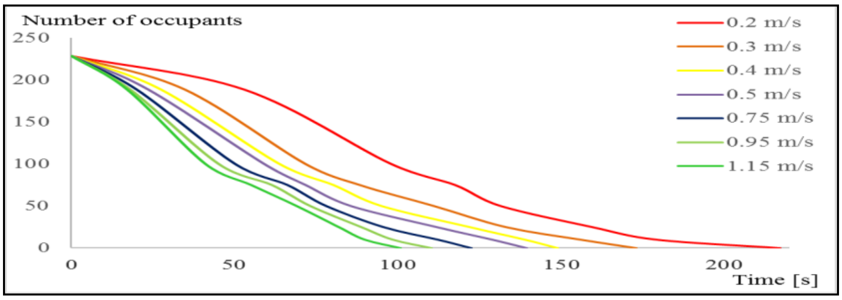

Figure 20 – Simulation results for the fastest times of the sixth case of the second scenario

Рис. 20 – Результаты моделирования скорейшего времени шестого случая по второму сценарию

Слика 20 – Симулациони резултати за најбржа времена шестог случаја другог сценарија

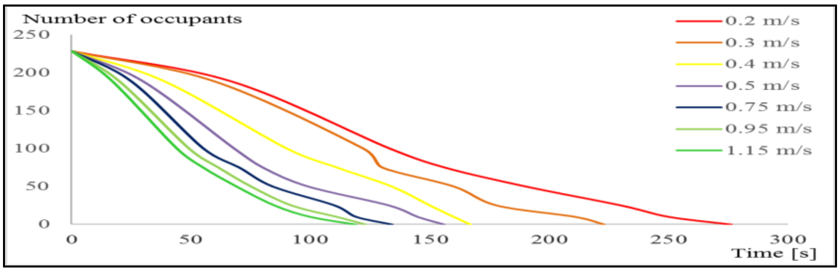

Figure 21 – Simulation results for the slowest times of the sixth case of the second scenario

Рис. 21 – Результаты моделирования самого медленного времени шестого случая по второму сценарию

Слика 21 – Симулациони резултати за најспорија времена шестог случаја другог сценарија

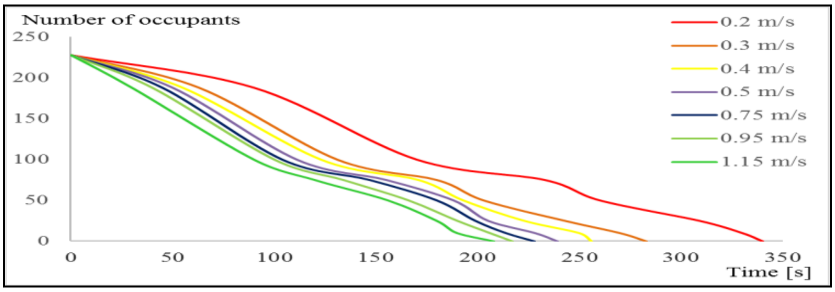

Figure 22 – Simulation results for the fastest times of the seventh case of the second scenario

Рис. 22 – Результаты моделирования скорейшего времени седьмого случая по второму сценарию

Слика 22 – Симулациони резултати за најбржа времена седмог случаја другог сценарија

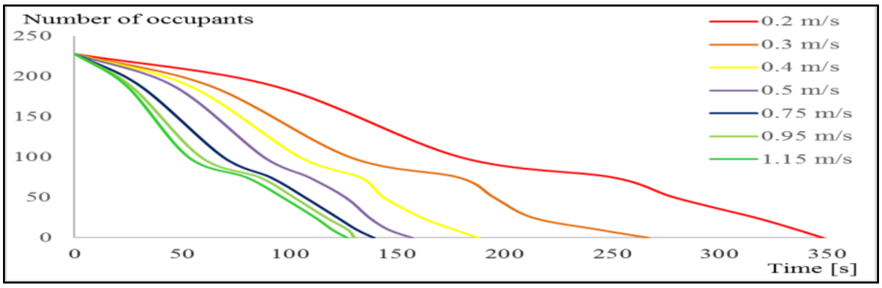

Figure 23 – Simulation results for the slowest times of the seventh case of the second scenario

Рис. 23 – Результаты моделирования самого медленного времени седьмого случая по второму сценарию

Слика 23 – Симулациони резултати за најспорија времена седмог случаја другог сценарија

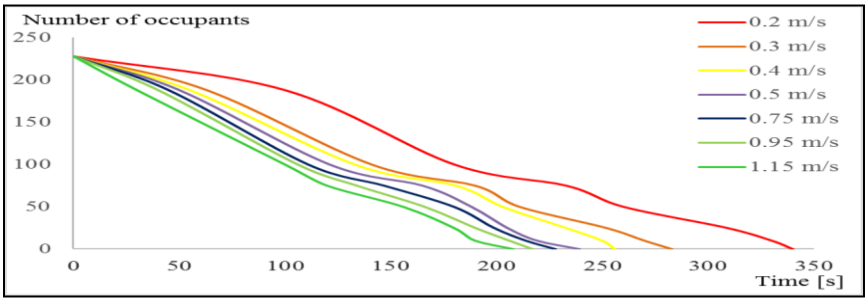

Figure 24 – Simulation results for the fastest times of the eighth case of the second scenario

Рис. 24 – Результаты моделирования скорейшего времени восьмого случая по второму сценарию

Слика 24 – Симулациони резултати за најбржа времена осмог случаја другог сценарија

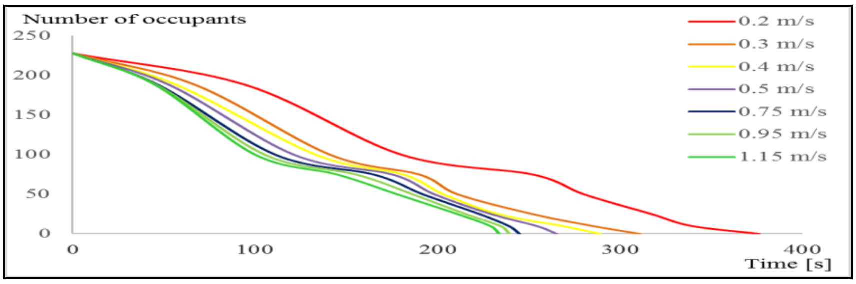

Figure 25 – Simulation results for the slowest times of the eighth case of the second scenario

Рис. 25 – Результаты моделирования самого медленного времени второго случая по второму сценарию

Слика 25 — Симулациони резултати за најспорија времена осмог случаја другог сценарија

Analysis of the results

The total number of realised simulations was 255. The first scenario involved evacuation from the aircraft but with the use of ordinary stairs, for noted speeds of passengers/occupants. The second scenario involved evacuation with the use of emergency slides. Because of eight doors with eight emergency slides, every potential combination of opened/closed doors was simulated. Of course, due to the paper limitations, only the fastest and the slowest possibilities of seven cases of the second scenario were presented (the first case of the second scenario had only one possibility).

The realized results for the first scenario showed that the longest time needed for a complete evacuation of the aircraft was for the case where one door was opened and one staircase in use, for the passengers/occupants' speed of 0.2 m/s and it was 1137.4 seconds (Figure 8). The shortest time needed for a complete evacuation of the aircraft was for the case where three doors were opened and three stairs in use, for the passengers/occupants' speed of 1.15 m/s and it was 132.4 seconds (Figure 10). These times are in line with similar calculated and realised times on other similar aircraft types.

There were a lot of potential possibilities needed for some cases from the second scenario, such as the second, the third, the fourth, the fifth, the sixth and the seventh possibility. Because of the paper size limitations, only the fastest and the slowest possibility for every of the noted cases of the second scenario would be presented. It was necessary to analyse this huge number of potential possibilities in order to comprise all potential cases.

There was only one possibility for the first case of the second scenario where all available doors/exits were opened. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 42.9 seconds. The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2 m/s and it was 122.7 seconds (Figure 11).

There were eight possibilities for the second case of the second scenario. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 46.6 seconds, when the third or the fourth or the fifth or the sixth door was closed (Figure 12). The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2

m/s and it was 134.7 seconds, when the first or the second doors were closed (Figure 13).

There were twenty-eight possibilities for the third case of the second scenario. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 48.8 seconds, when the first and the seventh doors were closed (Figure 14). The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2 m/s and it was 178.9 seconds, when the third and the sixth doors were closed (Figure 15).

There were fifty-six possibilities for the fourth case of the second scenario. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 64.8 seconds, when the second, the fourth and the seventh doors were closed (Figure 16). The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2 m/s and it was 191.3 seconds, when the third, the fourth and sixth doors were closed (Figure 17).

There were seventy possibilities for the fifth case of the second scenario. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 79.4 seconds, when the second, the fourth, the sixth and the seventh doors were closed (Figure 18). The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2 m/s and it was 221.6 seconds, when the third, the fourth, the fifth and the sixth doors were closed (Figure 19).

There were fifty-six possibilities for the sixth case of the second scenario. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 100.8 seconds, when the second, the fourth, the sixth, the seventh and the eighth doors were closed (Figure 20). The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2 m/s and it was 276.2 seconds, when the third, the fourth, the fifth, the sixth and the seventh doors were closed (Figure 21).

There were twenty-eight possibilities for the seventh case of the second scenario. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 127.5 seconds, when the second and the fourth doors were opened (Figure 22). The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2 m/s and it was 348.25 seconds, when the first and the second doors were opened (Figure 23).

There were eight possibilities for the eighth case of the second scenario. The shortest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 1.15 m/s and it was 208.5 seconds, when the third door was opened (Figure 24). The longest time needed for a complete evacuation of the aircraft was for the passengers/occupants' speed of 0.2 m/s and it was 376.65 seconds, when the second door was opened (Figure 25).

It is very important to note that the speeds of passengers/occupants were the same for all of the realised simulations, which is almost impossible in real situations because of a lot of factors such as fear and panic, different anatomy, positions, group and individual behaviour and many others. As an example, fear and panic can have a significant influence on human behaviour in terms of disorder and confusion, which directly implies an increase in evacuation time, accidents and even death epilogues (Kady & Davis, 2009; Deng, 2016).

In comparison to other similar papers, it is important to add that the realised simulation results were in line with similar realised simulation results, although the jam effect on a complete evacuation times has not been taken into account. In comparison with similar simulations realised in the simulation model of the Airbus A330-300 aircraft, the evacuation times were shorter in cases when several doors/exits were available (42.9 to 48.8 seconds against 50 to 59 seconds). These results were expected because the Airbus A330-300 has 285 passengers (Choochart & Thipyopas, 2020). Also, in the comparison with similar scenarios realised on the SSJ-100 aircraft, similar results were expected and realised, taking into account all potential differences between scenarios and aircraft with slight differences (79.4 seconds against 92 seconds) (Suharev et al, 2020). Moreover, it is very important for an evacuation strategy and evacuation times to know the cause for an evacuation (fire, bomb threat, forced landing, fumes, etc.).

Conclusion

The results realised in this paper showed the evacuation times for two different scenarios with the use of stairs and emergency slides. The use of simulation software in the solutions of evacuation problems is of great significance. The most important advantages of simulation software use in evacuations are efficiency, cost-effectivenesss and safety. For some situations, of course, it is almost impossible to determine all potential evacuation routes and to calculate all evacuation times, but, with the use of this software, it is possible to calculate evacuation times for different evacuation routes and for different speeds of occupants. Also, it would be almost an impossible task to create a real model of the aircraft and test all potential scenarios with real humans as passengers with different speeds in a safe, precise and inexpensive way.

The main contributions of this paper are in calculating evacuation times for different speeds of passengers/occupants and in determining which combinations of opened/closed doors/exits are the most effective. In case that an aircraft must land immediately, many failures can occur so passengers cannot use all predicted exits. Therefore, it would be very useful in some real situations for passengers and crew members to know how to behave, organise and where and how fast to go in order to leave the aircraft in the fastest and safest way.

Future investigations would be directed towards calculations of evacuation times and predictions of evacuation routes with the presence of children, immobile or hard mobile persons, crowd and jams potentials and consequences, etc inside the aircraft. These calculations and simulations will provide proper evacuation strategies and precisely calculate potential evacuation times even in these cases, taking into account all potential factors (speed of hard mobile or immobile persons, dimensions of wheelchairs, etc).

Simulation software in evacuation presents a very important engineering tool with important advantages and its use for complex evacuation problems is mandatory.

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ЭВАКУАЦИЯ ПАССАЖИРОВ ИЗ СОВЕРШИВШЕГО ПОСАДКУ САМОЛЕТА

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РУБРИКА ГРНТИ 73.37.17 Безопасность полетов воздушных судов
73.01.92 Пожарная безопасность
ВИД СТАТЬИ: оригинальная научная статья

Резюме:

Введение/цель: Самолеты являются одним из самых популярных и безопасных видов транспорта. Но несмотря на то, что регулярно предпринимаются различные меры безопасности, несчастные случаи все же случаются. Если самолет каким-то образом произвел посадку, независимо от степени его повреждения, главной задачей является быстрая и безопасная эвакуация пассажиров из самолета. Эвакуация пассажиров является очень сложной и ответственной задачей в силу различных факторов, таких как степень повреждения, наличие огня, скорость пассажиров, паника, страх и пр. Поэтому

чрезвычайно важно предусмотреть возможные способы эвакуации, возможные стратегии и маршруты эвакуации. Состояние приземлившегося самолета может быть разным, поэтому необходимо произвести быструю и безопасную эвакуацию пассажиров.

Методы: В данной статье для расчета необходимого времени эвакуации и возможных маршрутов эвакуации применен метод имитационного моделирования. Моделирование проводилось в программе для моделирования эвакуации в чрезвычайных ситуациях Pathfinder.

Результаты: Исследование проведено на соответствующей имитационной модели самолета с трапами и эвакуационными горками. Результаты исследования показали время эвакуации по двум разным сценариям, с учетом различной скорости реагирования пассажиров.

Выводы: Использование программного обеспечения для моделирования эвакуации является весьма эффективным способом с точки зрения безопасности, стоимости и предсказуемости. Этот тип программного обеспечения является обязательным инженерным инструментом для эффективного и точного решения эвакуационных и аналогичных задач. Цель данной статьи заключается в представлении возможных сценариев эвакуации пассажиров из совершившего посадку самолета.

Ключевые слова: эвакуация, самолет, моделирование, пассажир.

ЕВАКУАЦИЈА ПУТНИКА ИЗ АВИОНА НА ЗЕМЉИ

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ОБЛАСТ: авијација, безбедност и здравље људи
КАТЕГОРИЈА (ТИП) ЧЛАНКА: оригинални научни рад

Сажетак:

Увод: Авиони представљају једна од најкоришћенијих и најбезбеднијих саобраћајних средстава. Ипак, и поред предузимања многих сигурносних мера, несреће се дешавају. Без обзира на степен оштећења, уколико авион ипак слети, најважније је да се путници брзо и безбедно евакуишу. То је веома комплексан и захтеван задатак због неколико различитих фактора, као што су степен оштећења, присуство ватре, брзина путника, присуство панике и страха итд. Зато је веома важно да се предвиде могући начини евакуације, као и евакуационе стратегије и руте. Авион *који је слетео може бити у различитим стањима, тако да је брза и сигурна евакуација путника веома важна.*

Методе: За прорачун потребних времена евакуације и могућих евакуационих рута коришћен је симулациони метод. Симулације су реализоване у симулационом софтверу Pathfinder.

Резултати: Резултати овог рада реализовани су на одговарајућем симулационом моделу авиона са степеницама и тобоганима и показали су евакуациона времена за два различита сценарија, за различите брзине путника – окупаната.

Закључак: Употреба симулационог софтвера у евакуационим ситуацијама врло је ефикасна. Ова врста софтвера је сигурна, јефтина и има могућност предвиђања. Представља обавезан инжењерски алат за ефикасније и прецизније решавање евакуационих и сличних проблема.

Кључне речи: евакуација, авион, симулација, путник.

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