PASSENGERS' RESCUING IN CASE OF IMMINENT DISASTER OF LARGE AIRPLANES

Constantin Sandu[1], Dan Brasoveanu[2], Valentin Silivestru[1], Bogdan Filipescu[3], Radu Constantin Sandu[4]*

[1]COMOTI, Bucharest, Romania
[2]Systems Engineering Group Inc. (SEG),MD, USA
[3]Teletrans. Craiova, Romania
[4]S.C. Structural Management Solutions S.R.L., Bucharest, Romania
[*]Corresponding author: E-mail : constantin.sandu@comoti.ro

ABSTRACT

Air traffic is growing rapidly. Although current flight safety is extremely high, and the number of accidents with the number of flights decreases continuously, the risk of fatal crashes cannot be accepted indefinitely.
The problem of rescuing large aircraft passengers in case of imminent disaster is difficult and had no satisfactory solution yet. Using a parachute is a viable solution only for small airplanes with no more than 6 passengers. Large airliners cannot use this system because the parachute would be unsuitable large (hundreds of meters in size).
The authors of this article propose an original system for passenger's rescue, which involves rescue modules composed of groups of 2, 3 or 4 seats depending on the specific type of aircraft.
When disaster becomes imminent and forced landing is not a viable option, the rescuing modules slide onto the airplane sides in a precise sequence then parachutes open automatically. The rescuing modules are designed to protect the passengers from air stream during launching. It is demonstrated that due to the specific design, aircraft, strength, weight and manufacturing costs are insignificantly affected.

KEYWORDS: aircraft passengers saving, aircraft disaster, passengers' parachuting

1. INTRODUCTION

Due to continuous increasing of air traffic, passenger planes with very high capacity that can carry over 500 passengers have been built lately. Obviously, although at present the current flight safety is extremely high and is augmenting continuously. However, because the increased number of flights and flight hours the number of fatal accidents could become significant at global level. This could happen because regardless of technical safety, human factor remains a major cause of accident. Although at global level, the number of fatal accidents is and will be very small compared to the total number of flights, this risk cannot be accepted indefinitely.
The problem of rescuing large aircraft passengers in case of imminent disaster is one of the most difficult aviation problems and has no satisfactory solution yet.
Using a parachute is a viable solution only for small airplanes with no more than 6 passengers. The parachute is folded, compressed and stored in compressed state in a special location placed at on top of the small plane fuselage. In case of imminent disaster, the pilot can open the parachute to save the airplane and passengers. So far this system has saved dozens of small planes from crashes.
Large airliners cannot use this system because the parachute would be exceedingly large (hundreds of meters in size). Moreover, the parachute would have a very large volume, be difficult to fold and open. Also the parachute release and opening would require too much time. For these reasons, the pilot's ability to successfully manage a forced landing is the only hope of rescuing passengers today.
But the forced landing is not always an option: In numerous documented cases, pilots knew the crash is imminent and safe landing is impossible. For passenger aircraft an inoperative flight control system, a severely damaged lift surface such as a wing, impending collision, or inability to control flight, etc. means imminent disaster. Some solutions relying on airplane segmentation into several pieces equipped with separate parachutes have been proposed for rescuing passengers of large airplanes. These solutions cannot be applied for the same reasons discussed above.

The authors of this article propose here an original rescue system for passengers involving the use of modules for 2, 3 or 4 passenger seats. This system is presented in the next sections of this paper.

2. PRESENTATION OF SOLUTIONS PROPOSED BY NOW FOR AIRCRAFT PASSENGERS RESCUE

One of the most recent solutions for passengers' rescue was proposed by aviation engineer Vladimir Tatarenko (member of special investigation commission for aircraft accidents) [1] who worked for Antonov.
Tatarenko observed that statistics of aviation accidents prove that these accidents are caused by human errors in 80% of cases concluding that in future fatal accidents are unavoidable.
For saving aircraft passengers he proposed detaching the whole passenger cabin from the rest of aircraft (fig.1), free falling (fig.2), opening two large twin parachutes and reducing of falling speed (fig.3) and landing with the help of bottom inflatable dampers and solid rocket engines (fig.4).

Figure 1: Detaching of passengers' cabin

Figure 2: Free falling of passengers' cabin

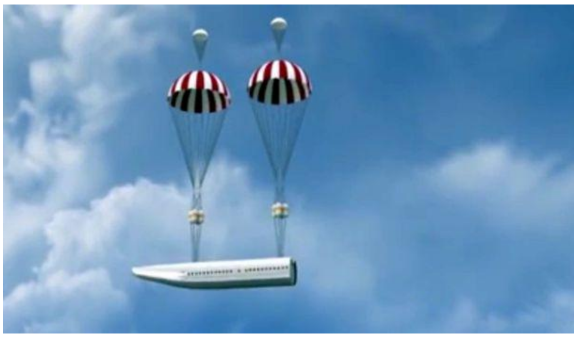

Figure 3: Braking of passengers' cabin falling with twin parachutes

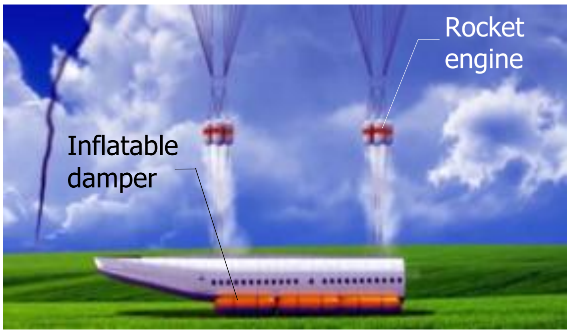

Figure 4: Landing of passengers' cabin using inflatable dampers and rocket engines

This solution cannot be applied for large passenger aircraft because the parachutes would be very large. Furthermore, it is difficult to fix the passenger cabin by an upper beam. That beam should be very strong for supporting the whole passenger cabin and the passenger cabin should be very strong for withstanding braking forces during parachutes opening. Additionally, this solution does not work when the wing is placed under or in the middle of fuselage.
There are some other solutions which involve separation of aircraft in several parts but their application requires an extensive redesign of the aircraft while the problem of the large areas of parachutes' surfaces is not yet solved.

3. PRESENTATION OF THE NEW SOLUTION FOR AIRCRAFT PASSENGERS RESCUE

The solution proposed in this paper considers the experience accumulated from small aircraft passengers such as Cessna and Cirrus. These small planes have a rescue parachute placed in a compartment over the cockpit in the center of the wing. The parachute is made of ultra-light composites material weighting 30 pounds and occupying a very small volume because after wrapping is compressed by an 11-ton press. The passengers are saved together with the entire aircraft when the pilot deploys the parachute. This solution already saved the lives of hundreds of people. [2]
Boris Popov from manufacturer of whole-plane parachutes Ballistic Recovery Systems (BRS), designed BRS parachutes for small aircraft carrying up to five people and tries now to design and install parachutes on planes accommodating up to 20 passengers in the next five years. He considers, too,

that the large commercial airliners will be equipped with a parachute recovery system, yet without recommending a solution for such large aircraft. It is really difficult to design a parachute system for carrying the weight of a passenger aircraft like Airbus A380 which can transport up to 853 people and is over 400 times heavier than a small personal aircraft. Such a parachute system would consist in multiple parachutes becoming too complex, bulky and heavy. It was evaluated that about 0.1sq m of parachute surface area is necessary to safely bring down a load of 0.5kg. Thus, in the case of Boeing 747 having about 500 people on board, 21 parachutes would be necessary, each of them being as large as a football field. [2]

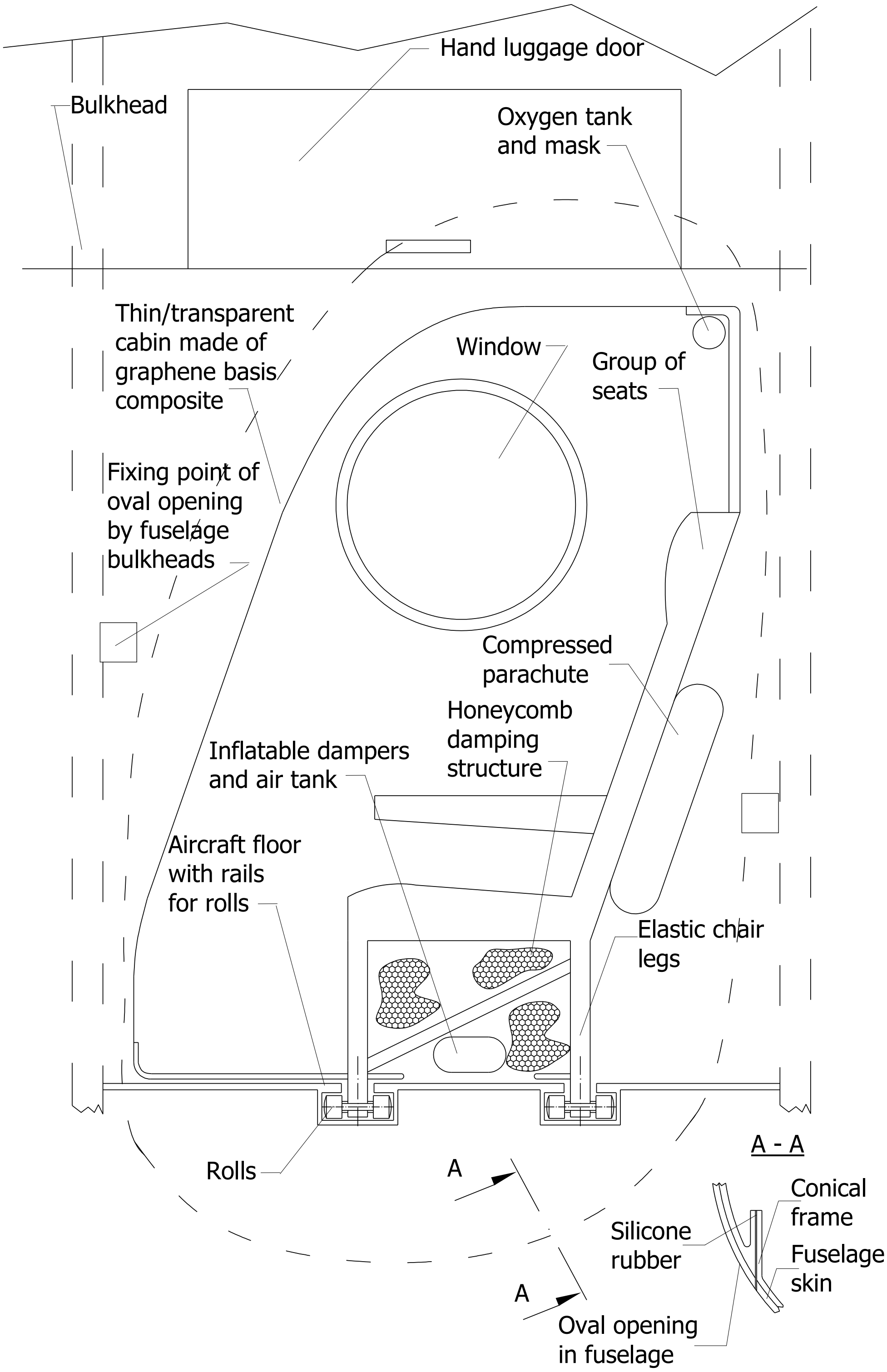

Figure 5: New solution proposed for rescuing of aircraft passengers

The new solution for aircraft passengers rescue relies on small/ admissible changes of aircraft design for saving of groups of 2, 3, 4 passenger because most passenger planes have 2-3 seats per side and 4 or 6 in the centre (if the aircraft is very large). The 2, 3 or 4 seats are affixed to floor by small rolls which can move in slots (rails) existent in the aircraft floor (fig.5).

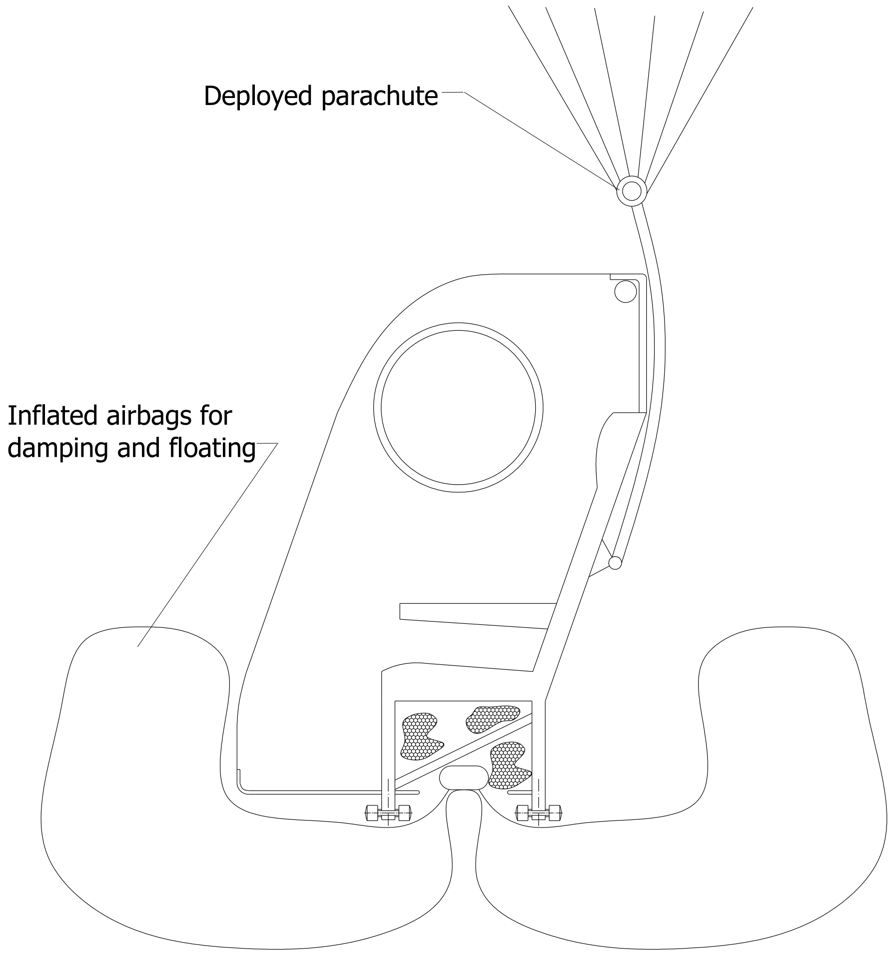

Figure 6: Landing of seat modules according to the new solution

Consequently, the groups of seats can slide along rails to the airplane sides together with a small oval portion of fuselage fairing. The oval portion is located between the two adjacent ribs of fuselage. This oval portion has a conical frame for joining with the similar conical frame fixed by ribs and fuselage fairing. The oval portion is connected by each adjacent rib in one point and the sealing between the conical surfaces is done with silicone rubber. Behind each side of group of seats there are two compressed parachutes placed in two pockets. If disaster is imminent, at the pilot command, the groups of seats slide in a programmed sequence to both airplane sides. Each group of seats is actuated by a set of 3 cartridges which are ignited progressively. After ejection from aircraft, another set of 3 cartridges which are ignited progressively pushes each group of seats upwards. Finally the two parachutes of each seat are extracted automatically by two other cartridges. The launching sequence and timing of cartridge ignition is calculated to keep sidewise and vertical accelerations to acceptable levels and all the groups of seats are kept at a safe distance from aircraft and one another. Each group of seats is encapsulated in a compact transparent cabin made from several layers of graphene impregnated with a transparent epoxy resin. The capsules protect the occupants from the air stream after ejection from aircraft. In normal state, the units are fixed to the floor using two locks and the oval portion is secured to the two adjacent fuselage bulkheads by 2 other locks. After the pilot presses the ejection button, the sequence of ejection is controlled by an independent computer, which commands the unblocking of all the locks and the ignition of pyrotechnic cartridges that laterally push each unit. The launching sequence is: the groups of seats from the rear side of

fuselage are launched first, then launching continues to the front of fuselage, including pilots' group of seats and cabin crew group of seats. After a group of seats is ejected from aircraft, other two pyrotechnic cartridges extract the two parachutes for opening. After the parachutes open, an airbag made from several layers of graphene impregnated with silicone rubber inflates under each unit. The airbags dampen the landing shock and provides flotation for the group of seats in case of ditching (fig.6). In addition, the landing shock is dampened by a honeycomb structure placed under the seat and the elastic legs of chairs. The group of seats section contains an oxygen tank and masks for passengers during descent. In the case of spaceplanes the cabins should have side walls due to the very high flying speed and height.
An example of launching sequences is illustrated in fig.7 for Fokker 50.

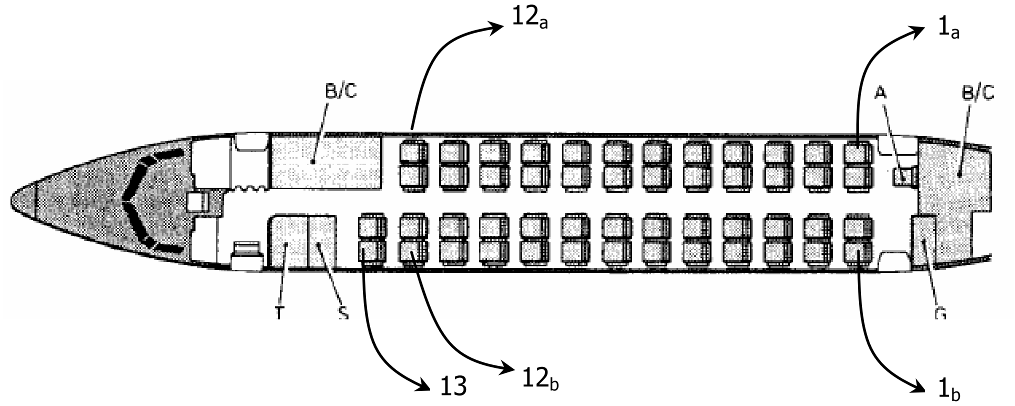

Figure 7: Evacuation of passengers at Fokker 50

The sequence of launching must maintain a horizontal distance between adjacent parachutes of at least five times the diameter of canopy. [3]

4. DISCUSSION ON DESIGN CHANGE FOR AIRCRAFT EQUIPPED WITH THE NEW PASSENGERS RESCUE SYSTEM

The present rescue system does not require major design changes for existing aircraft or additional expensive equipment for manufacturing.

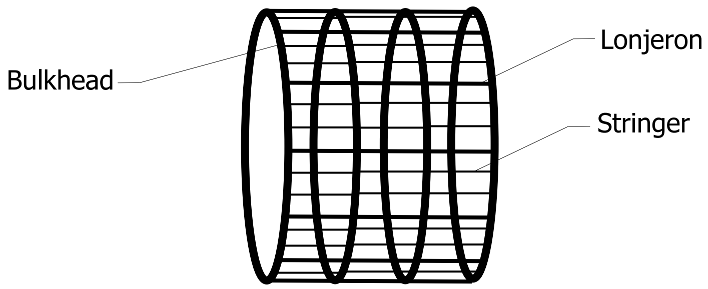

Figure 8: Semimonocoque fuselage

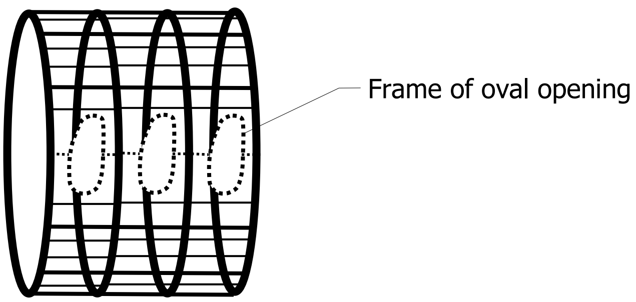

Figure 9: Semimonocoque fuselage transformed for the rescue system

For implementation of this rescue system, the seat pitch of aircraft must be increased from 34-36 in to 41-43 in. Additionally the seats must be placed exactly between fuselage bulkheads.
In figs 8 and 9, one can see the transformation of a monocoque fuselage for incorporating the rescue system. In fig. 8 it is presented a normal monocoque fuselage. In fig. 8 is presented the same fuselage with central lonjeron and upper and lower central stringers replaced by the frame of oval opening which is connected to the side of bulkheads.
This change is possible because the main bending stress of fuselage has minimum values in fuselage skin near the seats (fig.10).
Although the distance between bulkheads must be increased by about 20%, the frame of oval opening reduces the central bulking which appears when the distance between bulkheads is too large. [4]

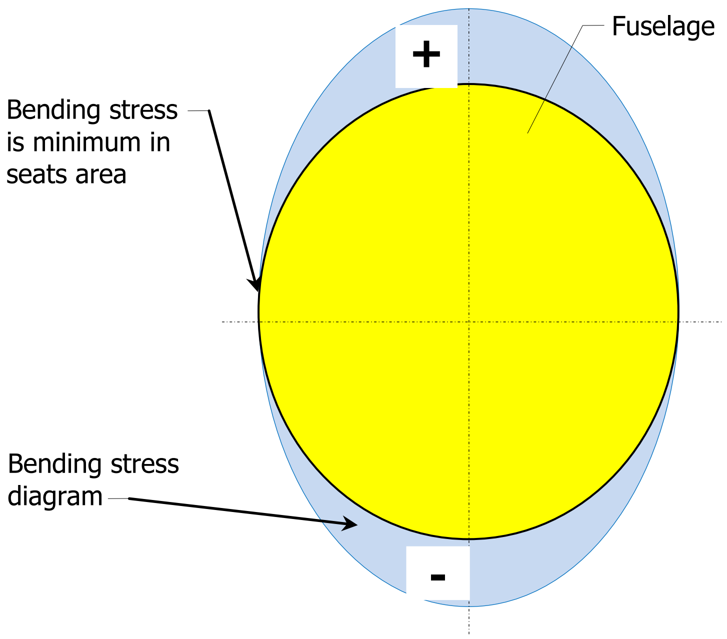

Figure 10: The bending stress in the fuselage skin and lonjerons/strings

In the case of a flying wing aircraft (fig.11), launching of groups of seats on a side is much more difficult because of the presence of leading edge of wing. Upward launching is difficult, too, because the passengers cannot tolerate the high accelerations involved in this type of launching. Downward launching is difficult, too, because of luggage space and landing gears.

Figure 11: Boeing 797 aircraft

5. CONCLUSIONS

▪The passengers rescuing system for large aircraft presented in this paper proposes as rescue units composed of 2, 3 or 4 passengers to be ejected through fuselage sides in a controlled sequence.

▪Experience from manufacturing small aircraft (up to 5 seats) shows that passengers can be rescued using parachutes if a light weight parachute is placed at the top of fuselage. The system for large aircraft presented here is similar except for application to rescue units composed of 2, 3, 4 seats each provided with two parachutes.

▪This system can be applied with minor changes of present aircraft design.

▪Analyzing this rescuing system, one can understand that there are not significant issues related to manufacturing aircraft with such system. The main issue is related to marketing. The market could require such aircraft in the near future.

REFERENCES

1.http://www.independent.co.uk/travel/detachable-cabin-invented-to-save-lives-during-plane-crashes-a6814311.html;

2. http://www.bbc.com/future/story/20131223-should-planes-have-parachutes;

3. Stein, K., Tezduyar, T., Kumar, V., Sather, S., Benney, R., Thornburg, E., Kyle, C., Nonoshita, T.; 2003; Aerodynamic Interactions between Parachute Canopies, ASME, Vol. 70, JANUARY 2003;

4. Arunkumar, K.N., Lohith, N., Ganesha, S.H.; 2012; Effect of Ribs and Stringer Spacings on the Weight of Aircraft Structure for Aluminum Material, Journal of Applied Sciences, 12: 1006-1012, 2012