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Improvement on the Design of Overhead Stowage Bin for Commercial Aircraft

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Abstract
The sudden and unexpected movement in flight can cause the item stored inside the overhead (OH) stowage bin shifted and falls into the passengers and flight crews. This incident may cause discomfort and severe injuries to them.In this study, a set of survey questionnaires has been distributed to the passengers and flight crew to identifythis issue. The existing design of the overhead stowage bin has been evaluated and a new design with safety features has been proposed based on the results obtained from the survey and design analysis. The safety featureis designed to fill the gap between stowage and the door to hold the stored items in a fix position whenever the flight encounters an unexpected movement. Three design has been proposed (Design 1 (D1), Design 2 (D2) and Design 3 (D3)) and based on the finite element analysis, D3 was found the most durable structure and able to withstand the high force applied withoutbending. Thus, it is recommended to used D3 to improve the design of the OH stowage bin to prevent injuries caused by falling objects during unexpected movement in flight.

***Keywords:** (OH) stowage, passengers and flight crew to identifythis issue.*

1. Introduction

Commercial airlines are the common transportation used to travel from one destination to another and it is very important for every airline to have the highest level of care and persistence in safety. Airline passengers are generally exposed to the whole surrounding in the aircraft cabin (ICAO, 2011). During travel, the passengers are getting used to bringing carry-on luggage such as laptop, luggage carries, briefcase, baby stroller and other objects (Lesley, 2015). They are likely stuffing as much as they can into their carry-on luggage before they board on the plane. The luggage is placed in the aircraft cabin baggage which is equipped with an overhead stowage bin and a door with a latch to secure the compartment (Simmons, 2015). If there is unexpected movement occurred on the aircraft, it is affecting the position of the luggage and may loosen the latch or hook that holds the compartment door. On top of that, the overhead bin sometimes might be overfilled beyond their load capacity. Even when the over-stuffed compartment door is closed and latched,

items may still fall because the bin latches are overstressed and cause the door open spontaneously (Garg et al., 2017). This situation has the potential to cause an accident whenever the passenger or the flight crew open the compartment door, the loosen object will fall and might cause an injury to the head, back and neck. It is estimated that 4,500 falling item injuries occur each year which involved passengers and flight crews (Rozmaryn, 1998). In this study, the potential risk or danger due to falling objects from the overhead stowage

bin will be identified and a new design of stowage bin with safety feature will be proposed to prevent the falling object due to unpredictable movement in flight.

2. Methodology

Industrial Survey

A set of survey questionnaires is distributed randomly to the flight passengers and cabin crews. The questionnaires focused on the subjects' perception of the risk of falling objects and the existing design of the overhead stowage bin.

Evaluation of Existing Overhead Stowage Bin Design

The dimensions of overhead stowage bin of Boeing 737 (B737) has been selected as a reference in designing the safety features of the overhead compartment in this study.

Stress Analysis

Stress analysis using Finite element simulation is used to test the strength of the structure of the designed safety features.

3. Results

Industrial Survey

In total 100 respondents involved in this survey, which 53% of the subjects are female and 47% are males. The results of the survey revealed that 75.6 % subjects choose "high safety and security level" as a suggestion to improve the overhead stowage bin design while about 24.4% subjects choose for "better item arrangement". In other words, the respondents aware that safety design is more important.

The Existing Overhead (OH) Stowage Bin Design and Dimensions

The existing design of the overhead compartment in B737 was not occupied with any safety barrier to hold the item inside the OH stowage bin. If there is any unexpected movement occurred,the potential of objects falling from the OH stowage bin is high due to lack of safety design. Table 1 shows the dimensions of the B737 overhead compartment and the schematic drawing of the OH stowage bin is presented in Figure 1.

Table 1: Table shows the existing overhead stowage bin in B737 commercial aircraft

Description	Dimensions
Length	80 in./2032mm
Height	20 in./508mm
Width	32 in./812.8mm
Length of one door	40 in./1016mm

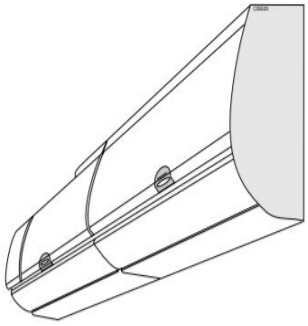

Figure 1: Schematic Diagram of Overhead Stowage Bin forB737

Overhead Stowage BinDesign Analysis

The safety feature for the OH stowage bin has been designed based on the dimensions of the B737 OH compartment. There are three design has been developed known as Design 1 (D1), Design 2 (D2) and Design 3 (D3) as depicted in Figure 2, 3 and 4.

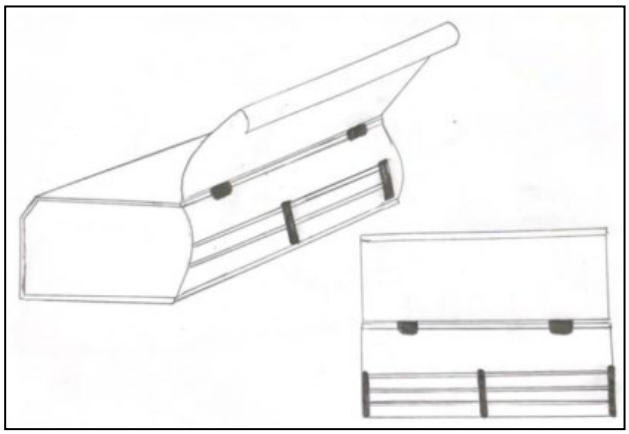

Figure 2: Design 1

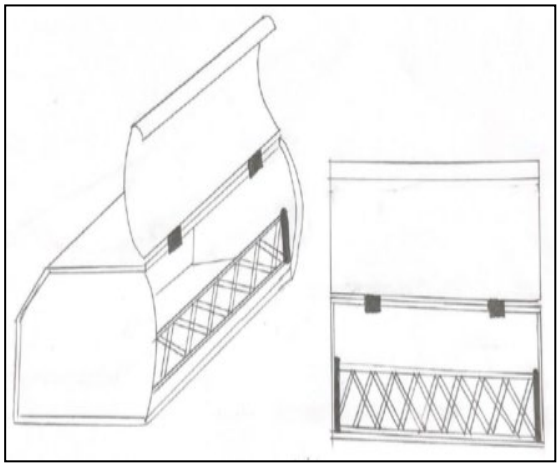

Figure 3: Design 2

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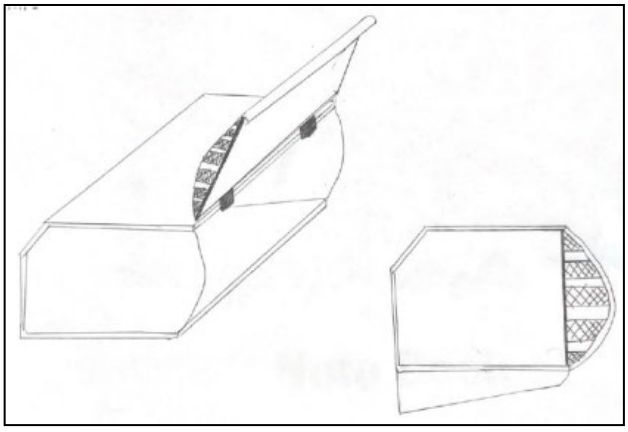

Figure 4: Design 3

The result of analysis on Design 1 shows that the high-stress fields spark on the clamped areas and the centre of the safety features. The low-stress fields dominate the safety features from the left to the right and from the bottom to the top. Meanwhile, for Design 2 the results show that the highest stress was located at the area of the clamp and Design 2 is suitable to be placed in front of the overhead compartment entrance. The barrier is able to hold the items at the compartment if there is unexpected movement occurred.

The analysis result for Design 3 shows that the centre of the structure of Design 3 was evenly at low-stress area even high force of (69 N) was acting on the structure. Even though there was a green colour area which indicated of medium stress area, the structure still can be improved by having both edges of the structure supported. In fact, Design 3 is much rigid compared to Design 1 and Design 2. Both (D1&D2), were found to bend when force is applied.

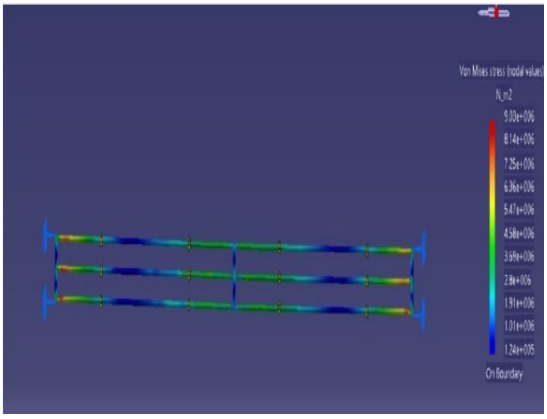

Figure 5: Stress Analysis Result for D1

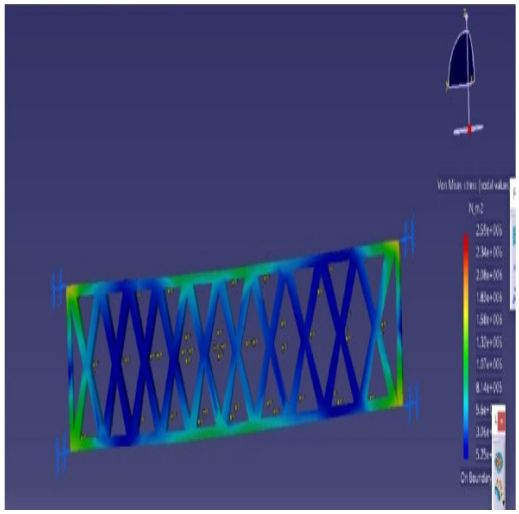

Figure 6: Stress Analysis Result for D2

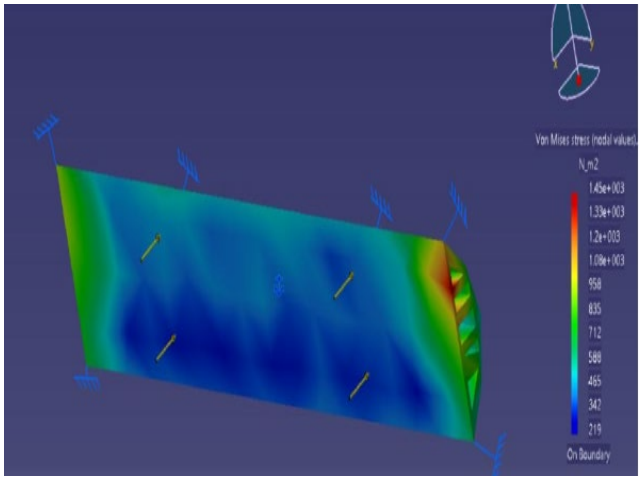

Figure 7: Stress Analysis Result for D3

Based on the result of analysis from the three designs proposed in this study, Design 3 has been recommended and the dimension is presented in Figure 8.

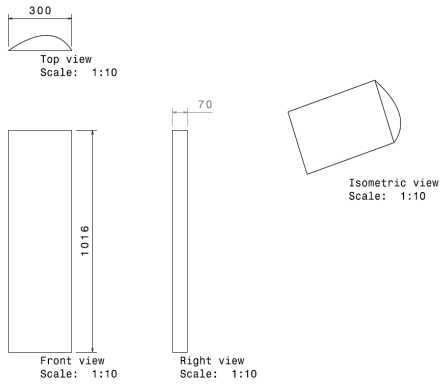

Figure 8: Design 3 – Recommended Dimension

4. Discussion

The aim of this study is to improve the design of commercial aircraft overhead stowage bin to prevent falling objects due to sudden and unexpected movement in flight. A set of survey questionnaires has been distributed to the airline passengers and crews. In total, 100 respondents involved in this survey and it is found that almost 76% of the subjects strongly agreed on having a safety barrier to increase the safety ofthe overhead compartment. Some of them have experienced falling objects from the overhead compartment due to unexpected movement.

It is practically easy to arrange the item in the existing design of the compartment and the items may easily fall when there is unexpected movement occurred. In order to improve the design of the stowage bin, the existing design has been reviewed and three new design was proposed named as Design 1, Design 2 and Design 3. Design 1 consists of two long thick frame with three support and able to withstand the load due to variable sizes of stored items. Meanwhile, Design 2 used the X-shape for the barrier which is more appropriate for the front compartment usage. This is because the X-shape which come from the triangle shape where the enhancement of barrier strength makes it able to hold or support the unexpected falling item from the overhead stowage bin itself.

Design 3 has curved shape safety features and follow the shape of the overhead compartment door. The result of stress analysis also showed thatthe centreof the structure of Design 3 hasa low-stress area even though high force applied to the structure. The result also showed that Design3 is more rigid and reliable, compared to Design 1 and Design 2. On top of that, Design 1 and 2 obviously tend to bend when force is applied to it. Thus, Design 3 is found able to withstand the load from the items stored in the compartment and the safety features will help to prevent the risk of falling objects from the OH stowage bin.

5. Conclusion

In conclusion, airline passengers and flight crews agreed that it is important to improve the design of the overhead stowage bin. The proposed design of overhead stowage bin should havea safety feature as shown in Design 3 to prevent the risk of falling of objects during unexpected movement in flight.

References

[1] Garg, P. Gupta, P., &Guven, U. (2017). Personal Overhead Stowage Bins To Ease Flight Boarding And Disembarking And Enhance Passenger Experience. 7th European Conference for Aeronautics And Space Sciences (Eucass), 1–13. https://Doi.Org/10.13009/Eucass2017-562

[2] ICAO. (2011). The Economic And Social Benefits Of Air Transport. Retrieved from https://www.Icao.Int/Meetings/Wrdss2011/Documents/Jointworkshop2005/Atag_Socialbenefitsairtransport.Pdf

[3] Lesley. (2015). What Can I Hand Carry On Board My Flight? Update on 22nd March 2017. Retrieved From https://Economytraveller.Com/What-Can-I-Hand-Carry-On-Board-My-Flight/

[4] Rozmaryn, L. M. (1998). Human Factors & Sporting Goods, Oddly Shaped Items Have Highest Injury Rates In Study Of Falling Overhead Baggage.

[5] Simmons (2015), Aero 15 – Overhead Stowage Bin. Retrieved from https://www.boeing.com/commercial/aeromagazine/aero_15/overhead_story.html