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Design and Fabrication of Pneumatically actuated Emergency Exit System in Aircrafts

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ABSTRACT: The designing of emergency exit system such as evacuation slides in aircrafts has become more difficult due to stringent laws laid by FAA. Earlier in mid-1960's the actuation time of slides was 25 seconds in fair normal days. But nowadays a time limit for actuation of the evacuation system has reduced to about 6 seconds during normal or in adverse weather conditions as per FAA. It has also posed certain challenges in the aviation industry. Slides are favoured to be lighter and be light and fit inside an aircraft door or below the emergency exit window

So to overcome the abovementioned problems design and fabrication of an emergency exit system operated using pneumatics is carried out in present work. In this type of evacuation systems a pneumatic cylinder is used to slide down the roller when the magnetic switch is actuated in doors due to repulsive force. The magnetic switches are connected to microcontroller thus activating the relay. Once the relay is activated the solenoid valve attached to it will allow the air from compressor to pass to the pneumatic cylinder. This will cause the roller to slide down immediately for the passengers to evacuate the aircraft in situation of catastrophes within few seconds.

KEYWORDS: Emergency exit system, Pneumatic system, Microcontroller

I.INTRODUCTION

An emergency exit system such as an evacuation slide is a necessity in commercial aircrafts where in the exit doors of the aircraft are at height greater than 1.8m above the ground. The evacuation slides are expandable in nature which are inclined towards the ground which facilitates the passenger to slide to safety. [5]

Evacuation slides are compactly stored within the door inside the slide bustle. The evacuation slides also act as life rafts in case of emergency landing on waters. In todays sophisticated aircrafts evacuation slides actuate automatically on opening the doors in armed condition. [5]

The passengers are made to exit the aircraft onto wing by evacuation slides wherein in they start off from trailing edge and slide off further from the extending flaps in case the standard exit system fails to evacuate the passengers through main exit doors. Emergency exits are compact in nature compared to standard emergency exits on an aircraft. This results in reduced evacuation capacity, they are present in case of insufficient evacuation facilities in standard exit systems. In case of more than one standard emergency exit system the evacuation slides are not needed. The passengers have to open up the emergency exit system by themselves in case of adversities.

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Fig1. Evacuation slides [5]

Basically, there are two types of emergency exits. The disposable hatch type which is further subdivided into Type IIIA and Type IIIB.The type IIIA is one in which operator has to remove the the operator "plug type" hatch from its frame before disposing of it on the wing. The second type is the self-disposing found in modern aircraft which simplifies the opening of the exit and to minimise the chances of hatch blocking the exit. It is initiated by the passengers bypulling in and down on a handle fitted at the top of the door and actuating the exit's self-opening mechanism[5].

II. SIGNIFICANCE OF THE SYSTEM

The paper mainly focuses fabrication of pneumatically operated emergency exit system in aircrafts which helps in faster evacuation of passengers in case of adversities. The study of literature survey is presented in section III along with the objective set up for the current work carried out, Methodology is explained in section IV, section V covers the experimental results of the study, and section VI discusses the future study and Conclusion.

III. LITERATURE SURVEY

NTSB [1] carried out prospective study on emergency evacuation of Commercial aircrafts. They collected data from stakeholders such as passengers, crew, flight attendants and addressed issues regarding a) effectiveness of evacuation equipment b) adequacy of air carrier and c) communication problems during evacuation
Frederic Leclerc et.al [2].In this paper discussed “plug” type doors used on aircraft, particularly for military aircraft. In plug type aircraft door comprising a frame that can be used as fuselage of the aircraft, a panel articulated onto the frame.
Tomio Hamataniet.al [3] carried detailed study, the slide evacuation system, of an armed type. Wherein the base of the slide anchors to the fuselage of the airplane below the door. In an armed system, opening the door that is associated with the slide causes the evacuation system to activate. When activated, the system powers the door open and unfolds and inflates the slide using one or more pneumatic reservoirs of pressurized gas. In personnel disarm the system, the base of the slide anchors to the door. Thus, when the door opens, the base of the slide moves with the door and the system does not activate.
Martyn Amos et.al [4].In their work investigated the effect of door delay, and conclude that even a moderate average delay can lead to evacuation times that exceed the maximum for safety certification. The model VLTA suggests practical ways to minimize evacuation time, as well as providing a general framework for the simulation of evacuation.

From the literature survey the objectives set up for the current work are to facilitate evacuating people in case of adverse condition, to utilise pneumatic means to power the evacuation system, to have a compact evacuation system easily fitable within the aircrafts which could be easily operated by the passengers, crew or any one onboard the flight. Also the mechanism should be lighter, faster and accurate.

IV. METHODOLOGY

In the beginning literature survey is carried out by referring to some journals and objective was set to design an emergency exit system for an aircraft using pneumatic cylinders which will help passenger and crew of the aircraft to evacuate aircraft easily and safely very quickly without any injuries.

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Vol. 5, Issue 7 , July 2018

Initially the drawbacks in the currently used systems, further modification requirements and advancement to be done in our work was decided. Moving on further a conceptual design was prepared. Once functional requirements were satisfied then a with preliminary and detailed design was finalised, in which project specifications were assumed. Next step was selection of materials and components as per the requirement which are explained in detail below why it is selected and the decision of frame structure as rectangle since the aircraft door is in rectangle shape. Final step is creation of CAED model fabricated the very same CAED model and tested our model to get the good results compared to the one which exist. The methodology is well expressed in the following flowchart.

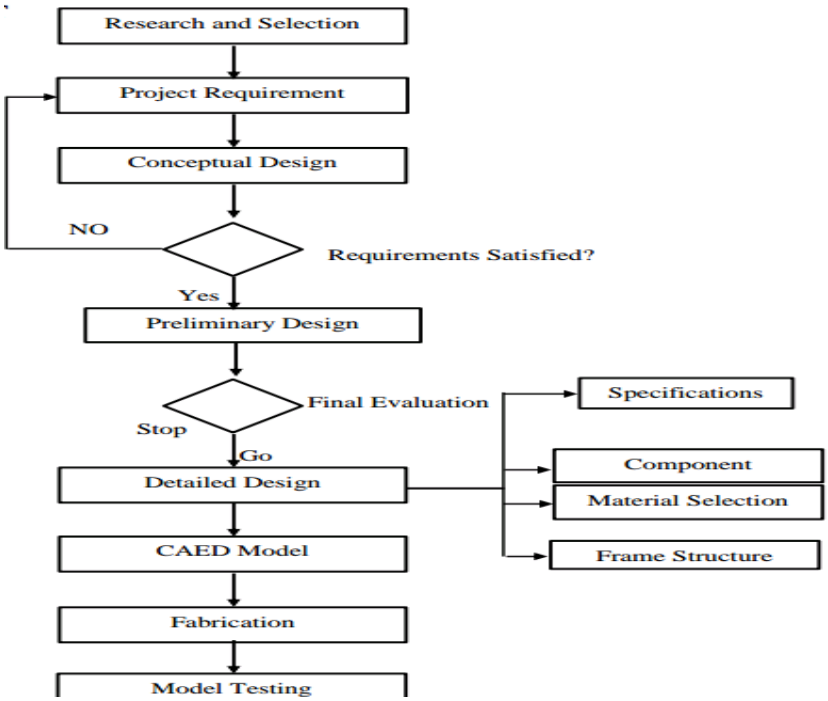

Fig.2Design Process Flowchart

A) Model specification for fabrication process

Table1. Model Specifications

Height	Width	Angle of Slider	Slider Width
6.5ft	2.5ft	60^{o}	2.3ft

B) Material Selection

1. Selected iron for frame as it is easily available and easy to machine.

Table 2. Properties of Iron used for frame structure

Melting Temperature	Young's Modulus E X 10^{6} Psi	Tension X 1000/ In^{2}
1535 ^{o}C	11.6	20^{a}

2. Used normal Std CF fibre for the slider

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Vol. 5, Issue 7 , July 2018

Table 3. Properties of STD CF fibre used for slider

Young's modulus 0^0 GPa	Ult. Tensile strength 0^0 MPa	Thermal Exp. Co-ef 0^0 Strain/K	Density g/cc
70	600	2.10	1.60

C) CAED MODEL OF THE PNUEMATIC POWERED EMERGENCY EXIT SYSTEM

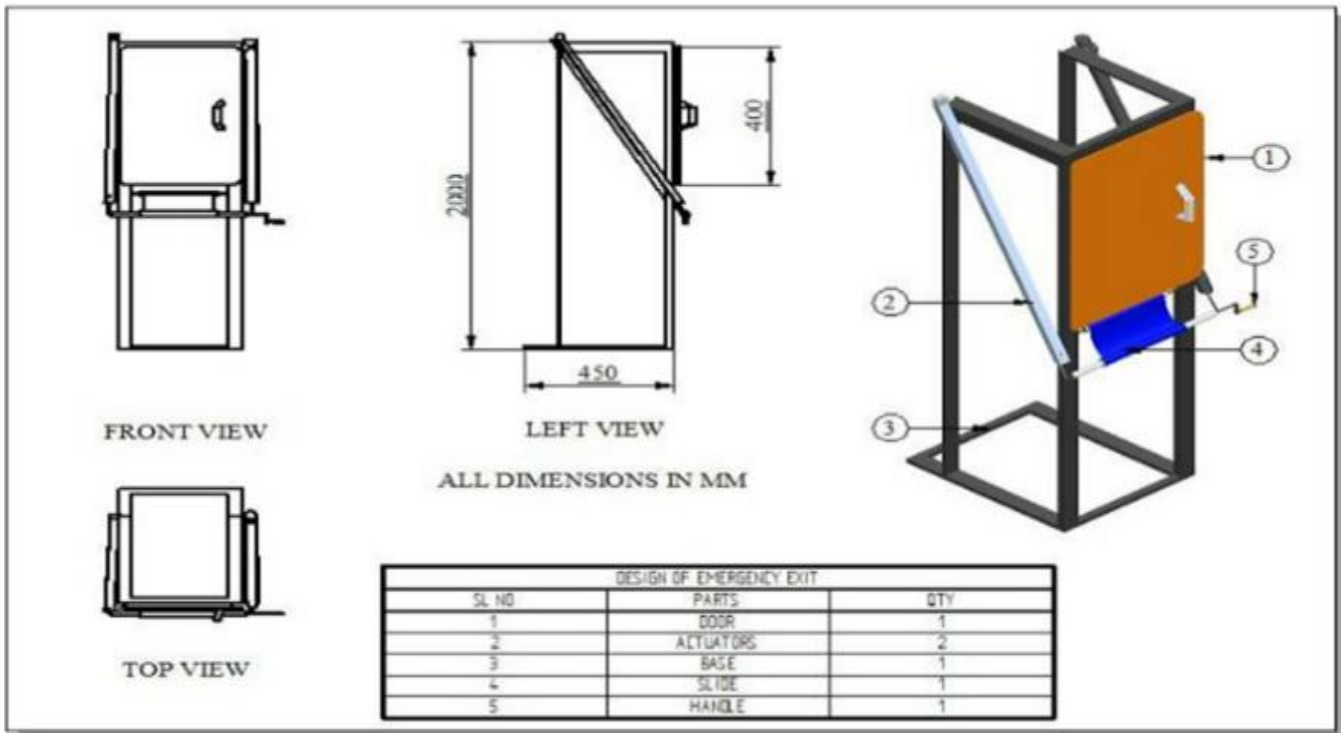

Fig 3. CAED Model of Pneumatically powered Emergency Exit System

The parts shown in the figure are as 1) Door 2) Actuators 3) Base 4) Slide 5)Handle

D) COMPONENTS USED FOR THE FABRICATION OF THE PNUEMATIC POWERED EMERGENCY EXIT SYSTEMS

a) Pneumatic cylinder b)Over wing exit door c)Solenoid Valve d) Magnetic switches e)Microcontroller

f) Relay G) Battery12 v, 1.3 AH

E) WORKING PRINCIPLE

During normal flight condition the emergency exit system is n be in closed condition. When the adverse condition arises the passenger seated next to the emergency door opens the emergency exit this causes the actuation of the magnetic switches which are nested within the emergency exit door system. Due to actuation of the magnetic switches a repulsive force is produced causing the switches to move apart. This induces a small voltage of 5 volts which is

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sensed by a microcontroller which causes activation of relay Once the relay is activated the solenoid valve attached to it will allow the air from compressor to pass to the pneumatic cylinder. This will cause the roller to slide down immediately for the passengers to evacuate the aircraft in situation of catastrophise within few seconds.

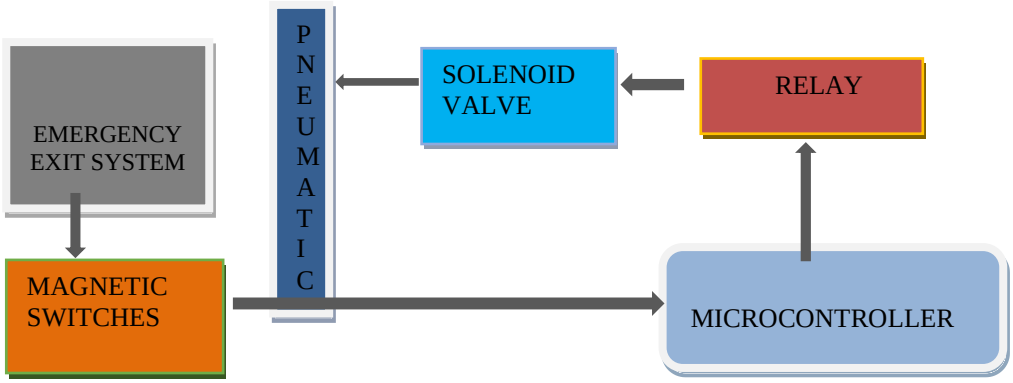

Fig 4. Block Diagram of Working Principle of Pneumaticpowered Emergency Exit System

V. RESULTS

The prototype model fabricated during the conducted project work provides following results:

- As soon as the emergency exit door is opened the evacuation slider deploys within 2-3 seconds which is the best result we have got comparing to the existing emergency exit system in aircraft.
- Once the purpose of the evacuation slider is complete and the exit door is closed, the slider retracts back to its initial position.
- Easy to slide since the slider deploys at 60 degree angle.

Fig.5 Fabricated model of Pneumatically operated Emergency Exit System

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ADVANTAGES

- The slider mechanism is supported by pneumatic power and thus not affected by cross winds. Puncture resistant and Cost saving

LIMITATIONS

- As there are mechanical linkages used in our concept, there may be problems arising with loads acting on them.
- It cannot be adaptable to shapes for emergency evacuation such as window exits. But in present days most of the aircrafts use trailing edge flaps deployment which are enough to reach the ground and enables passenger's evacuation. So, this limitation does not possess much problem.
- One more limitation is that the pneumatic cylinder does not withstand more weight.
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VI.CONCLUSION AND FUTURE WORK

By the foregone results it could be seen that the current work carried out has resulted in pneumatic powered emergency exit system which could help in evacuating the passengers in acute time span of few seconds. It is easy to operate, compact in nature.

FUTURE WORK

- More number of Passengers can be evacuated by increasing the size of the emergency exit door. Depending on the size of the door the slider size also varies.
- Engine bleed air maybe substituted in place of the compressor thereby saving the extra penalty of added weight of compressor and thus making the mechanism still more compact.
- By using advanced materials for fabricating the slider it could be made resistant to cross winds of high intensities and also other adverse weather conditions.
- Since the slider is light and compact enough it can fit below the door sill or emergency exit window.
- Furthermore researches should be made on this concept in order to make feasible to use at emergency evacuation system in aircraft.

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