APISAT 2019

2019 ASIA PACIFIC INTERNATIONAL SYMPOSIUM ON AEROSPACE TECHNOLOGY

SURFERS PARADISE MARRIOTT RESORT,
GOLD COAST
4 – 6 DECEMBER 2019

ENGINEERS AUSTRALIA

APISAT 2019

The Research on Aircraft Nose Landing Gear Bay Damage

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APISAT 2019

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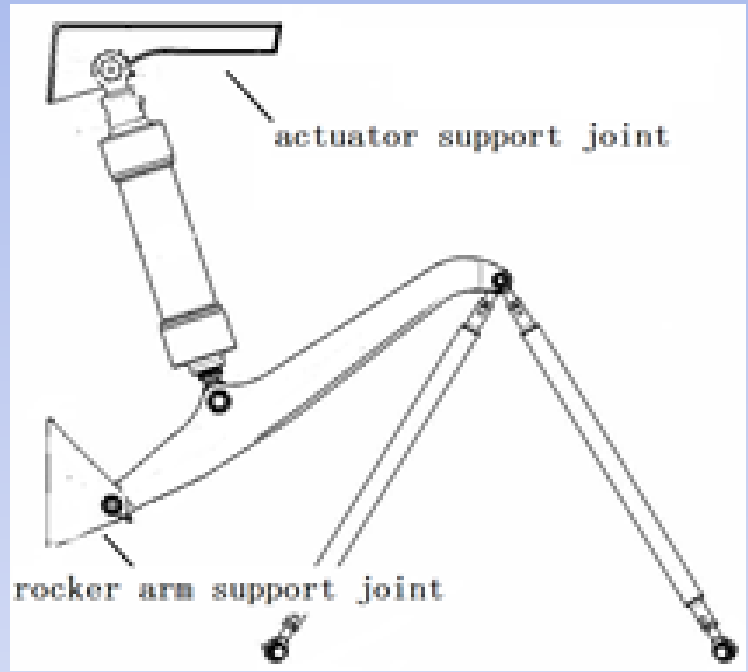
Background

Before the airplane left the factory, each system of aircraft includes the flight control system,the avionics system,the ring control system and so on needed to carry on a series of test inspection. In the process of system test ,some parts of the aircraft may not be fully installed, so all working parts of the aircraft were unpredictable.That situation was likely to occur unexpected circumstances and even caused damage to the aircraft parts. When a plane of the system was checked, a loud noise was heard from the front landing gear bay. The damage of the relevant structure of the landing gear was detected and the bolt was broken.

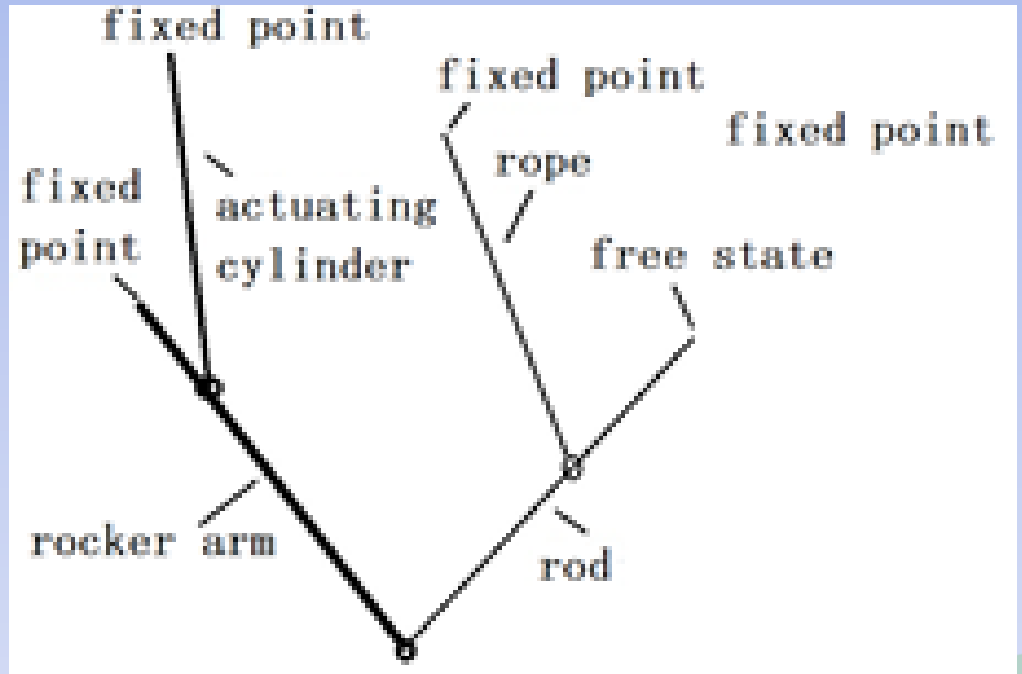
Accident Analysis

After on-the-spot observation, it was preliminarily decided that the accident resulted from the abnormal movement of the landing gear of the door retraction and extension mechanism, resulting in the tremendous noise.



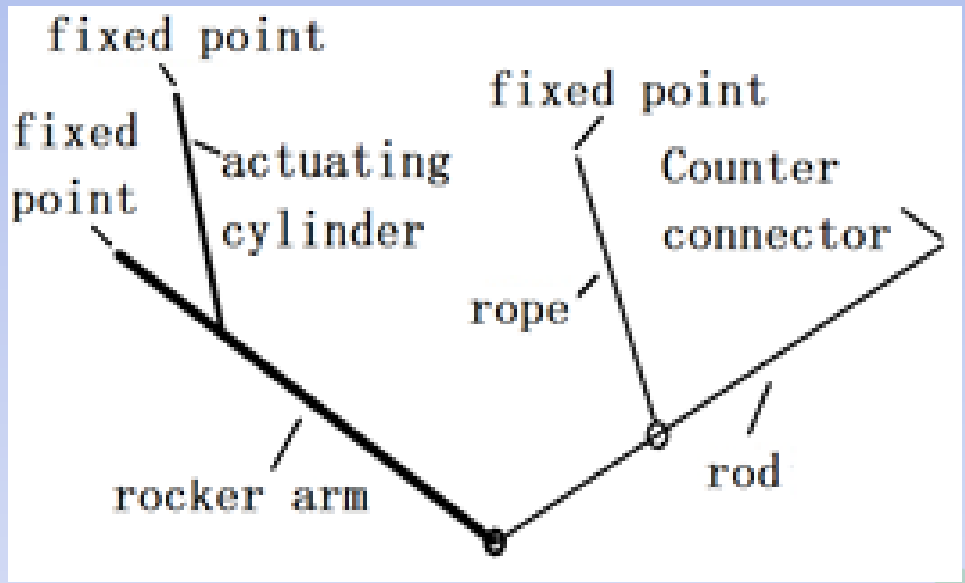
Accident Analysis

It was confirmed that before the accident occurred, the landing gear door actuator was in the extended state and the door were open.The door and the door tie were not connected, at the same time the two rods were hanged in the air by the rope.



Accident Analysis

During the system checking, the door actuator were working and began to shrink so that the door rods were moving. In the process of movement the door rods came into contact with the end of joint on the right side. In the end the door rods were unable to move freely. But the door actuator continued to pull on the rocker arm so that the carrying capacity of the structure was exceed, leading to the accident finally.



Accident Analysis

Through the relevant measurement and observation, the structure was damaged and the landing gear compartment structure bolts were broken, as follows:

1)The rocker bearing joint were teared;

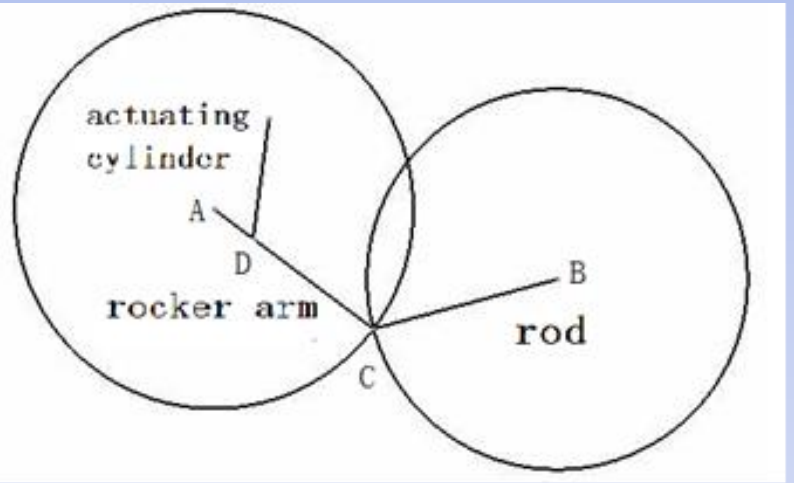
2)The door rods were distorted;

3)The right bearing joint was damaged;

4)The connection bolts were fractured.

Numerical Analysis

The location of the mechanism was needed to be determined by analysis firstly.It was assumed that the rocker bearing joint was at A, and the right cabin seat joint was at B. The intersection point of the actuating barrel and the rocker arm was D. Because the door rocker and door arm rods were respectively in the left and right arm support top hatch bearing joints. Respectively A and B as the center of the door rocker and the door rod length radius circle, two circles of intersection was at C.



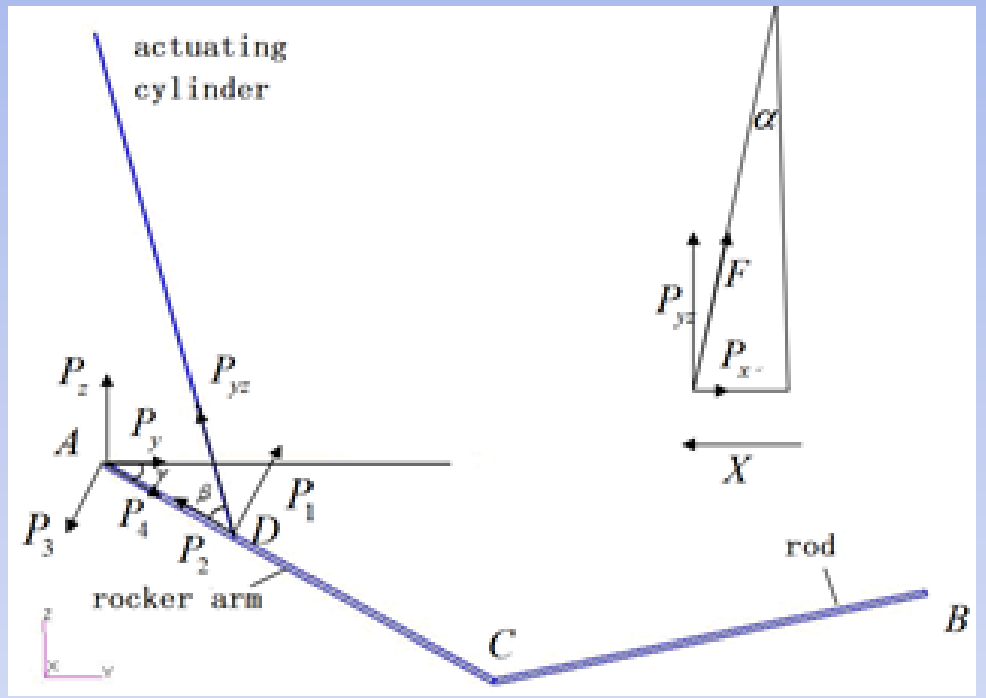
Numerical Analysis

$$P_x = F\sin\alpha \qquad P_1 = P_{yz}\sin\beta \qquad P_3 = \frac{2}{3}P_1$$

$$P_{yz} = F\cos\alpha \qquad P_2 = P_{yz}\cos\beta \qquad P_4 = P_2$$

$$P_y = P_3\sin\gamma - P_4\cos\gamma$$
$$= \frac{2}{3}F\cos\alpha\sin\beta\sin\gamma - F\cos\alpha\cos\beta\cos\gamma$$

$$P_z = P_3\cos\gamma + P_4\sin\gamma$$
$$= \frac{2}{3}F\cos\alpha\sin\beta\cos\gamma + F\cos\alpha\cos\beta\sin\gamma$$



F: the actuator force

Px: the X component

Pyz: the YZ plane component

P1: the component of perpendicular to the rocker arm

P2: the component of parallel to the rocker arm

P3: the force at the A point perpendicular to the rocker arm

P4: the force along the rocker arm

Numerical Analysis

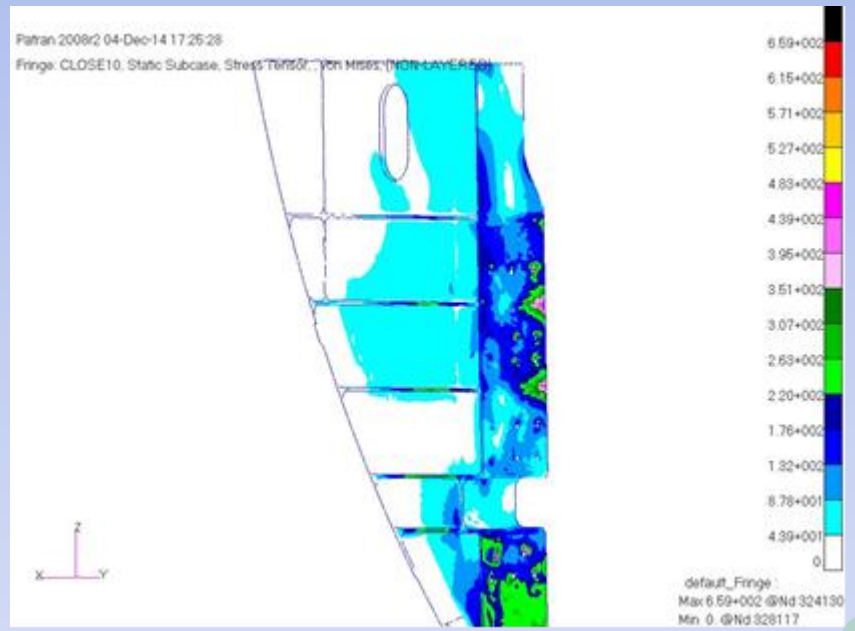
In accordance with the final state of the destruction, was 49° and was 26° . The load of the actuating cylinder was 78000N. Because the deflection angle of the barrel along the course can not be accurately obtained, it was assumed that the deflection angle increased from 5º to a certain angle.The load of the rocker arm support can be obtained, as shown in table 1.

Tab.1 Rocker arm joint load(N)

（° ）	Px	Py	Pz
5	-6839.55	-28912.42	57856.88
7	-9563.71	-28806.64	57645.19
9	-12276.2	-28665.80	57363.35
10	-13627.1	-28582.28	57196.22

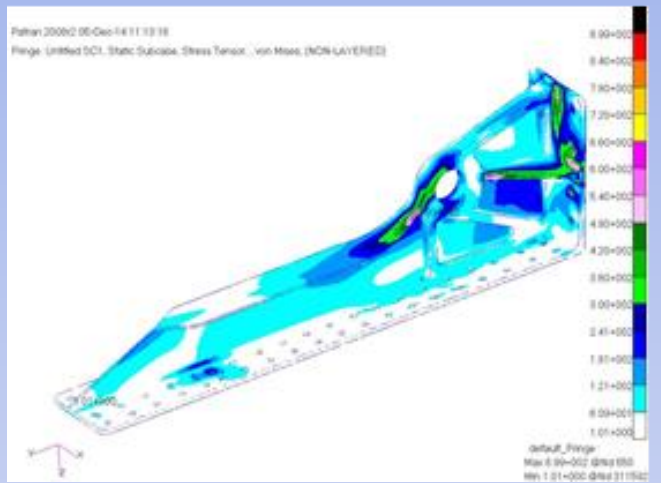
Numerical Analysis

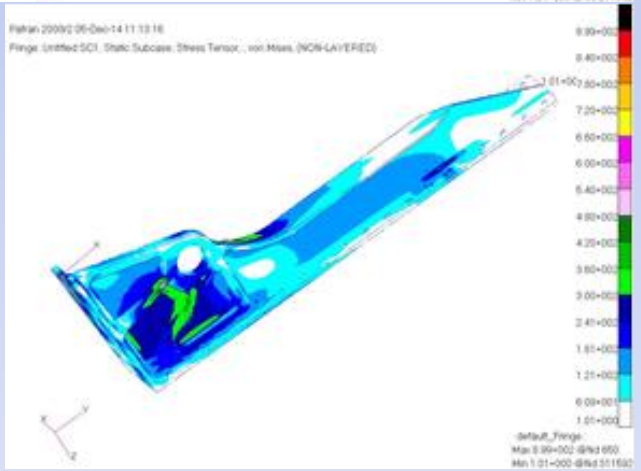
After calculation, figure 5 showed rocker bearing joint Von Mises stress distribution when the cylinder angle was 10º.It can be seen from the figure that the maximum stress on the frame structure had exceeded the allowable stress. It was coincided with destruction site.The schematic diagram of the rocker arm support bolts were shown in Figure 6. The results of the bolts were shown in Table 2 and table 3, and the No.17 of the rocker bearing joint bolt was broken and was in conformity with the damage condition. Thus, the state of the motion of the mechanism can be determined when the structure was damaged.



Numerical Analysis

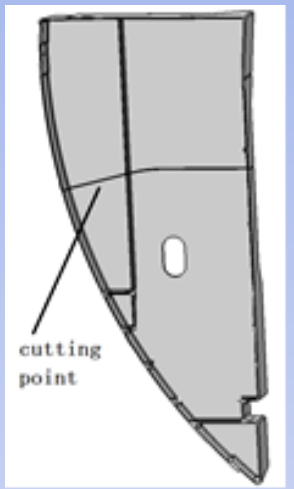
The stress distribution nephogram of the Von Mises of the actuating cylinder support were shown in Figure 8. The actuating cylinder meeted the strength requirement from the diagram. The actuating cylinder joint structure was not damaged.

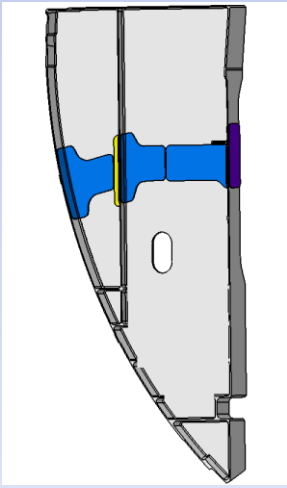




Damage structure rehabilitation plan

Through the preliminary field test and subsequent modeling analysis, a clear understanding of the damage structure and location of the front landing gear bay had been made, which laid a foundation for the repair of the damaged structure in the later stage. The structure damage repair scheme was: 1)The front door bearing joint seriously bruised and the front door rocker beared bending deformation, so two joints were scrapped and changed; 2)According to the site survey, the whole frame was not in a plane.It was a big difficult to change the overall frame, so the lower part of the frame larger deformation area was cuted and changed a new one, the upper part was still used. The front frame restoration was shown in figure 10.





Conclusion

Through the above analysis, we can draw the following conclusions and lessons:

- 1.The main cause of the accident was that the parts of the aircraft in the state was not clear and it was eager to detect system functions leading to some of the motion mechanism abnormal operation and aircraft structure damage;
- 2. Through investigation and analysis, the direct cause of the accident was defined, and the mechanical model was established to restore the whole process of the accident;
- 3. Through the establishment of finite element model, the mechanism of structural damage was simulated, and the validity of the model was verified. It provided a very important reference for subsequent repair;
- 4. Analysis of other important structures proved that other structures haved not been damaged, which saved valuable time and funds for aircraft repair;
- 5.Through the investigation and analysis of the accident, similar incidents wre prevented in the later work.

THANK YOU