STRUCTURE ANALYZE BUSHING OF CONTAINMENT RING USING NON-DESTRUCTIVE TEST FOR TURBOFAN OF AIR PLANES ENGINES

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STRUCTURE ANALYZE BUSHING OF CONTAINMENT RING USING NON-DESTRUCTIVE TEST FOR TURBOFAN OF AIR PLANES ENGINES

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Abstract: Containment ring is component on engine for turbofan engines of air plane. The function of Containment ring is for balancing assembly part as the shaft, retaining disk and fully bladed disk on turbofan of airplanes. The component of containment ring is bushing for join of part on engine. The joint process of production on bushing and ring using welding process. This study will discuss of structure analyze of welding area on containment ring using Non-Destructive Test (NDT). Method of analyze is additional chemical on welding area using ADROX for focusing crack are in material after welding process. The material of ring and busing is stainless steel FYNIS SUS304. The result show that welding areas of joint no any crack finding after 10 specimens tested of Containment ring. The checking method using additional chemical ARDROX 9814 (penetrant) in welding areas for inside and outside areas of the part.
Keywords: Containment Ring, Bushing, Non-Destructive.

INTRODUCTION

The aircraft is public transportation for passage high safety needed, the aero engine must be designed to successfully contain a failed turbine blade without any case penetration. The containment phenomenon of failed rotor blades is a complex process which usually involves speed and power of interaction of many turbo engine component, such as blade, contaminates structure, bearing support, engine mounting and so on. [1]. Containment ability and groove depth design of U type protection ring, Verification test on high-speed spin tester has been conducted and shows that protection ring with appropriate U structure can resist the impact of the disk burst fragments [2]. The Impact Load of Containment Rings During a Multiple Blade Shed in Aircraft Gas Turbine Engines, the result show that the situation modeled here is one where the initial blade fragments are contained but subsequent blade failures create large hoop stresses that result in brittle tensile failures in the ring [3]. Predicted facture Behavior of Shaft with improve Corrosion Resistance, the result show that Higher resulting values of J-integral for steel 1.4305 as opposed to 1.7225 can be noted. Results can be useful as a fracture parameter in fracture toughness assessment, although this procedure differs from experimental analysis. [4]. Approximate analysis of containment/deflection ring responses to engine rotor fragment impact, this collision analysis is combined with the spatial finite element of ring and a temporal finite difference solution procedure to predict resulting large transient elastic plastic deformations of containment/defections ring.

RESEARCH METHOD

The research method is using material SUS304 for bushing and welding material using Silver Alloy AG 25%. Material of busing will processing with CAM and check every lot production, if rejected material will disposal. After CAM process material will continue to assembly process (welding). Welding process using material silver AG25%. This material has good composition for welding performance. Performance of material will test using non-destructive test (NDT) ARDROX 9814. Welding area will check using X-ray machine for finding crack on the part. The final inspection will separate good condition and bad condition (crack) for disposal.

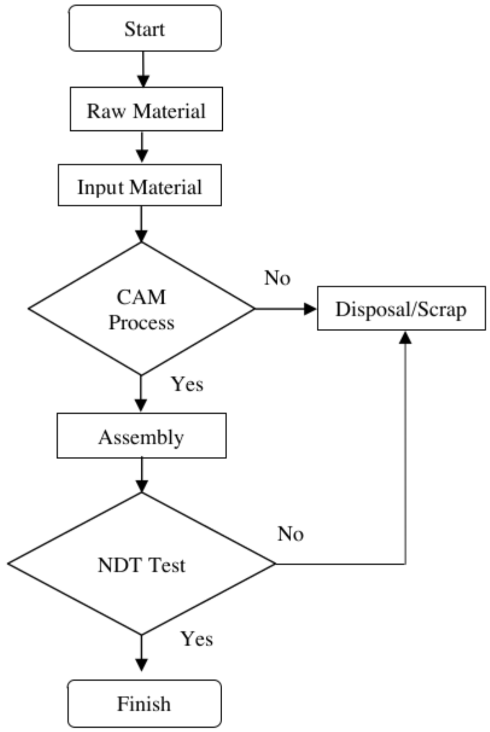

Figure 1. Research Methods

Material Composition

Bushing develops using composition like iron, carbon, chromium, nickel silicon, phosphrous, manganese and tin. At this research stage the main is iron 60~70% and chromium 18%. Material will process CAM process for make bushing and after finish process, continue for assembly (welding) process using silver AG25%.

Table 1. Material Composition of Steel

No	Composition	CAS Number	Percentage
1	Iron	7439-89-6	60~70%
2	Carbon	7440-44-0	0.10~0.15%
3	Chromium	7440-47-3	18%
4	Nickel	7440-02-0	8%
5	Silicon	7440-21-3	0.91~1%
6	Phosphorus	7723-14-0	0.045%
7	Manganese	7439-96-5	2%
8	Sulfir	7704-34-9	0.03%

Table 1 show that of Material Safety Data Sheet (MSDS) off bushing is 8% of nickel, 1% of silicon, 2 % of manganese and Sulfur 0.003%. With material process material (forming material) raw material will be formed as Fifure 2 (steel SUS304).

Figure 2. Steel SUS304

Figure 3. Silver AG25%

Figure 2 and Figure 3 show that material of steel and silver solder AG25%, for welding processing, based on table 2, Material Safety Data Sheet (MSDS), show that silver composition is 25%, Cooper 45%, Zinc 34% and Tin 1%. The higher content of silver will making faster melting time when welding process. It will be impact for structure of part.

Table 2. Material Composition of Silver

No	Composition	CAS Number	Percentage
1	Silver	7440-22-4	25%
2	Copper	7440-50-8	45%
3	Zinc	7440-66-6	34%
4	Tin	7440-31-5	1%

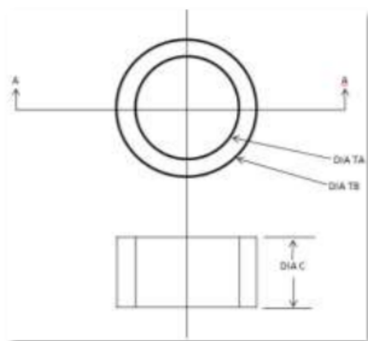

Figure 4. Drawing and Bushing

Table 3. Bushing Specification.

Reference	Dimension Limits inch (mm)
DIA C	0.22 - 0.24 (5.6 - 6.1)
DIA TA	0.402 - 0.406 (10.21 - 10.31)
DIA TB	0.595 - 0.605 (15.11 - 15.37)

Dwaing of bushing show in figure 4, cyclinder part with material SUS304 with detail size in table 3. Bushing will be develop based on size of containment ring size. The size is requirement of turbo fan or air planes engine standard. Table 3 show that DIA C 5.6 – 6.1 mm, DIA TA 10.21-10.31 mm and DIA TB 15.11-15.37 mm.

Scale Down Design and Dynamic Equivalence

The main objective of this research program is to design and develop a scaled down test rig that is capable of simulating what is happening in a real fan disk in gas turbine engines. In view of the size difference between our newly thought scaled down test set up and a fan disk, we must employ Buckingham dimensional analysis, also known as π-theorem, to ensure dynamic equivalence between the two systems. This will ensure that the results of the scaled down test rig are applicable to the realistic full-size disk. Our dimensional analysis revealed the direct relevance of four non-dimensional terms are needed to achieve dynamic equivalency of the two systems. These four governing non-dimensional terms account for the following pertinent variables: mass of the blade mb, length of the blade Lb, area moment of inertia of the blade Ib, Young's modulus of the blade Eb, mass of the shaft ms, length of the shaft Ls, area moment of inertia of the shaft Ls, Young's modulus of the shaft Es, and rotational speed of the disk ω. The four non-dimensional terms and their values for a fan disk of a typical gas turbine engine are given in Table 6.1. These values are calculated from the dimensions of a generic gas turbine engine model developed for blade shedding analysis by several research institutes and engine manufacturers

Table 4. Non-dimensional parameters used for dynamic equivalency.

Π Term	Expression	Value
Mass Ratio, Π1	$\frac{ms}{mb}$	13,8
Mass Ratio, Π2	$\frac{Ls}{Lb}$	1,1
Flexural rigidity ratio, Π3	$\frac{EsIs}{EbIb}$	17,600
(Flexural rigidity ratio, Π4	$\frac{EbIb}{mbLb\omega}$	$\frac{2400}{\omega}$

Setting CNC Lathe

When setting of CNC lathe need to analyze Rpm requirement for program, The main unit structure is optimized, and the dynamic stiffens of part. The machine is HT300 using spindle motor power 18.5KW, and maximum speed 3000 Rpm, will calculate Rpm requirement as below:

$$n = \frac{1000. Cs}{\pi. d} Rpm$$

$$n = \frac{1000 . 14}{3.14.6.1} = 730 \text{ Rpm}$$

Figure 6. CNC Lathe Machine

Table 5. Injection Machine Specification

No	Description	Unit	Injection Unit
1	Manufacture		Hanover
2	Model		CKX600H
3	Motor Power	kW	18.5
4	Length Maximum	mm	560
5	Spindle speed max	Rpm	3000
6	Motor Torque	N.M	20
7	Z-Axis Limit Stroke	mm	610

RESULT AND DISCUSSION

Result of CNC processing of Bushing of Containment Ring is is smoother when cutting of material of ring, based on calculation that setting of RPm machine is 730Rpm. The figure 7 show that of bushing process using CNC lathe and result of part smooth and no any broken-on part when cutting ouside and inside process.

Figure 7. Machining Process and Bushing

When processing completed for bushing next step for analyze of bushing dimension using and pressure test. Figure 8 show that processing of analyze dimension and pressure test before assembly, this process will check material are safe for continue assembly (welding) process. This process is requirement for fatigue material evidence.

Figure 8. Containment Ring and Bushing

Bushing will assembly with containment ring, Assembly process (welding) will be using material silver AG25, when welding process operator will be checking of structure of part, and checking process will using visual and spot test.

Figure 9. Containment Ring and Bushing

Figure 9 show that result of weldig process bushing and containment ring, the quality check will be using visual analiyis. Qauality will check OD welding area for failure of weling or crack issue. When visual test has been completed will be countinue for check structure of material using spot test.

Figure 10. Containment Ring and Bushing

Figure 10 show structure of material for more detail failure analysis of part, failure of wellding or crack issue. The reslut show that material no any issue when welding process or cutting process in CNC machine. In table 6 show that of 10 sample tested, the result of all part no any crack issue on material after welding process.

Table 6. Spot test result

No	Data	Crack (Y/N)
1	Sample 1	N
2	Sample 2	N
3	Sample 3	N
4	Sample 4	N
5	Sample 5	N
6	Sample 6	N
7	Sample 7	N
8	Sample 8	N
9	Sample 9	N
10	Sample 10	N

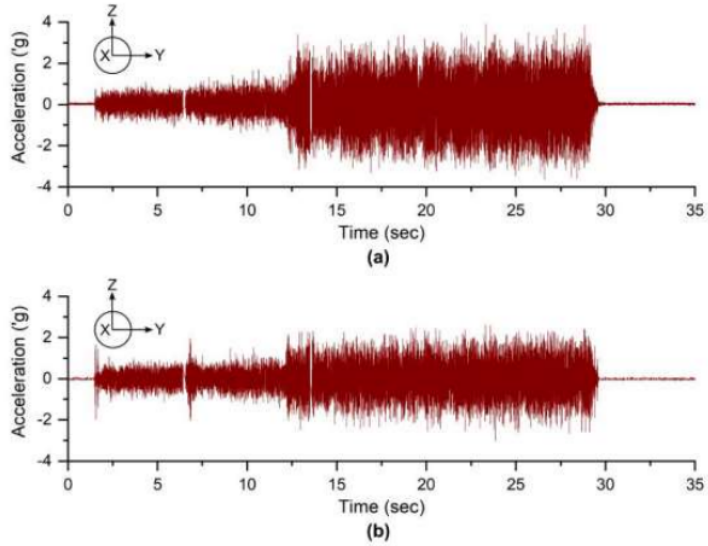

Figure 11. Acceleration test

. When bushing was completed all test, will continue for trial acceleration test, in figure 11 acceleration are presented in the strain gauge measurement. Rational constant of speed of 2500 Rpm for 15 second. When adding acceleration of ±3g, containment ring, rational constant of speed on 1500 Rpm for 5 Second.

CONCLUSION

The result show that Contaiment Ring are important part of air plane, welding process will effect to structure of part. Setting of Rpm CNC machine is 730Rpm and based on spot test of part after welding and after adding ARDROX 9814 (penetrant), is no any crack on 10 speciment test. When bushing was completed all test, will continue for trial acceleration test, in figure 7 acceleration are presented in the strain gauge measurement. Rational constant of speed of 2500 Rpm for 15 second. When adding acceleration of ±3g, containment ring, rational constant of speed on 1500 Rpm for 5 Second.

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