Structural Analysis of the Forming Press for Airplane Stringers

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Abstract: - Due to the rapid growth of the world's midsize aircraft market, the complete aircraft industry has been expanding its global outsourcing. It is to respond to these changes in aircraft production paradigm through the development of forming systems in a intelligent stringer for mid-sized aircraft. During the machining for stringers, a large load is applied to the forming press and this causes stress in the structure of the forming press. At this time, excessive stress may cause plastic deformation of the forming press and lose the function. Therefore, this study is to secure the rigidity and safety through the structural analysis for the C-frame and the press head of the forming press.

Key-Words: - Forming press, C-frame, Press head, Punch block, Structural analysis, Equivalent stress

1 Introduction

In the aircraft stringer machining equipment forming press, stress and deformation occur in each configuration device by a load generated during the stringer forming operation. However, excessive stress or deformation may lose the function of the forming press [1]. Therefore, this study is to predict the intensity of the main components of forming press and verify the design based on the loading conditions applied during stringer forming of the forming press.

2 Initial model and material properties

2.1 Initial model

Fig. 1 shows modeling of each part of the forming press.

2.2 Material properties

SM45C is used for the press head including the punch upper block and SS 400 is used for the C-frame. As materials with excellent machinability and strength, SM45C and SS400 are widely used in the industrial site. The material properties for materials applied in this study are as shown in Table 1.

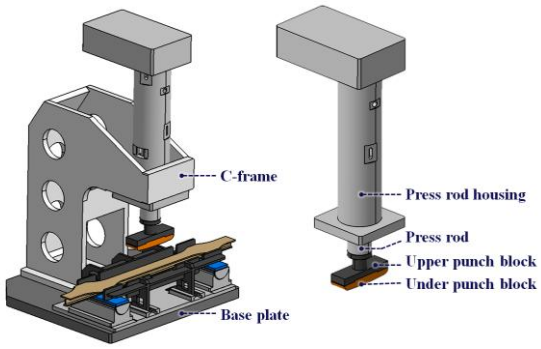


Fig.1 Forming press modeling

Table 1 Material properties of SM45C and SS400

Material	Density (kg/m^3)	Yield strength (MPa)	Possion's ratio(ν)
SM45C	7,600	370	0.3
SS400	7,850	245	0.29

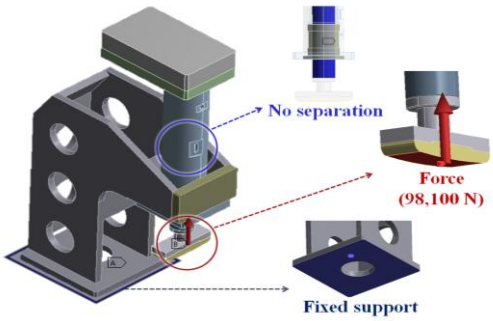
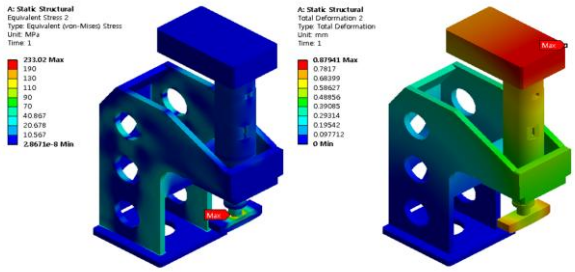
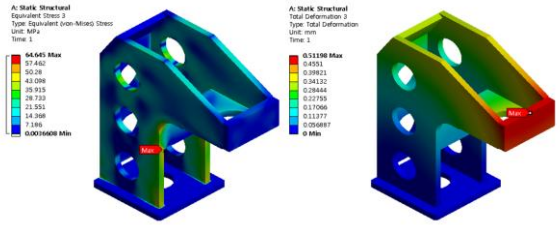


Fig. 2 Boundary conditions of structural analysis



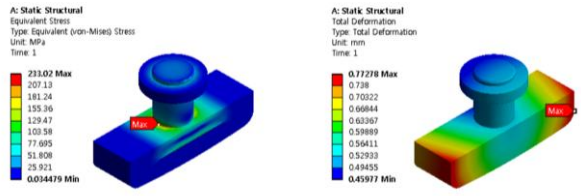
a) equivalent stress b) total deformation

Fig. 3 Results of the forming press



a) equivalent stress b) total deformation

Fig. 4 Results of the C-frame



a) equivalent stress b) total deformation

Fig. 5 Results of the press head

3 Structural analysis

Tetrahedron-shaped solid elements were used as finite element mesh for the structural analysis. The finite element size was set to 10 mm in the C-frame, 5 mm in the press rod housing and 5 mm in the press rod.

Table 2 Results of structural analysis

Parts	Equivalent stress (MPa)	Total deformation (mm)	Yield stress (MPa)	Safety factor
C-Frame	64.64	0.51	245	3.77
Press head	233.02	0.77	370	1.58

Since the C-frame is made with bolt tightening with the base plate, fixed support was given to the floor surface of the C-frame. As a load condition, 10 ton, the load generated during stringer machining was given to the bottom of punch under block. Because slip occurs on the contact surface between the press rod and the press rod housing, no separation was given as a contact condition and a complete bonded condition was given to the contact surface of the remaining structures.

4 Results of the structural analysis

4.1 Results of structural analysis for the C-frame

According to the structural analysis result of the C-frame, maximum equivalent stress 64.64 MPa occurred in the C-frame center as shown in Fig. 4. In the case of total deformation, the maximum value occurred in the front cover edge of the C-frame. A safety factor is 3.77 and the structural stability could be confirmed by securing more than 1.

4.2 Results of structural analysis for the press head

According to the structural analysis result of press head, maximum equivalent stress 233.02 MPa occurred in the point where upper punch block and press rod are connected as show in Fig. 5. In the case of total deformation, the maximum value occurred at the edge of under punch block and upper punch block. A safety factor is 1.58 and the structural stability could be confirmed by securing at least 1. The structural analysis results for the C-frame and press head can be found in Table 2.

5 Conclusion

Through this study, the structural analysis results of the forming press for a load occurring can be summarized as follows during the machining for stringers: It can be found that equivalent stress values obtained through the structural analysis of the forming press are 64.64 MPa in the C-frame and 233.02 MPa in the press head, lower than a yield stress value. At least one of safety factor was secured and the forming press can be considered to have secured the rigidity and structural stability. We

are to check the weight lightening possibility of the forming press through further research in the future.

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