Final Report

Aerospace Engineering – MMME1049

Coursework 2

Aircraft Brake Assembly

Name:

Student ID:

University of Nottingham

UK | CHINA | MALAYSIA

March 26, 2025

Table of Contents

List of Figures

Executive Summary

This report presents the conceptual design and CAD assembly making of a light aircraft internal brake system developed for a 500 kg reconnaissance UAV. The final design integrates a caliper assembly with dual brake pads, an axle and required fasteners and bearings all constrained within the provided wheel envelope. A piston-actuated braking mechanism was selected based on simplicity, performance and ease of integration. Standard components included M5 bolts, seals, and bearings that were used to ensure modularity and reduce complexity. The sizing calculations ensured that the brake could generate sufficient clamp force to decelerate the aircraft at over 1g, meeting the performance criteria. The design was optimized for weight, functionality and fit without modifying the provided wheel model. With additional time, the design could be improved by incorporating detailed finite element analysis (FEA) to evaluate stress concentrations, deformation under load and thermal behavior during braking. A more rigorous parametric study could also refine piston sizing, pad area and material selection to optimize performance to weight ratio.

Final Design

The final brake assembly was developed to fit fully within the provided light aircraft wheel assembly envelope. It consists of an axle, caliper body, dual brake pads and two hydraulic pistons operating in opposition. Standard M5 fasteners and off-the-shelf bearings were used to simplify integration and assembly. The caliper was fixed to the internal interface using six M5 bolts while the axle incorporated a locking interface with the provided wheel locknut. All parts were designed for minimal weight while ensuring structural integrity under braking loads. The following Table 1 shows the summary of the components based on their material and mass properties

Table 1: Summary of Components Designed for Aircraft Brake Assembly

Component	Material	Mass (g)
Caliper Body	Aluminium 7075	180
Brake Pads (x2)	Ceramic-Resin	60
Hydraulic Pistons (x2)	Steel	90
Axle	Mild Steel	240
Bearings & Fasteners	Steel	100
	Total Assembly	670

The following Figure 1 shows the weight breakdown pie chart of all the assembly parts as follow;

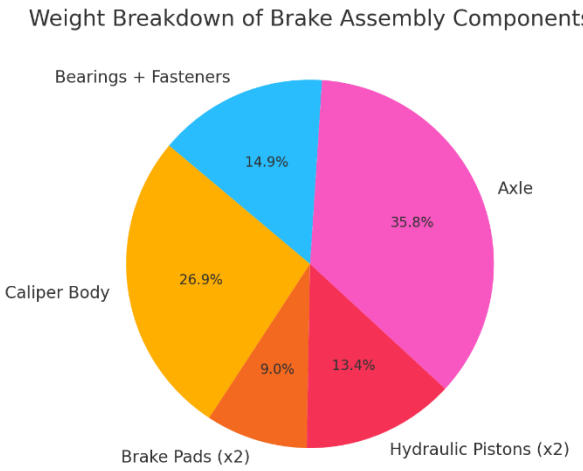

Figure 1: Weight Breakdown Pie Chart of Break Assembly

Key Calculations

To validate performance, brake force and torque requirements were estimated assuming the following input data given in Table 2.

Table 2: Key Calculations Input Parameters

MTOW	500 kg
Braked Wheels	2
Required Deceleration	1g (9.81 m/s²)
TYRE Radius	0.114 m
Brake Pad Friction Coefficient (μ)	0.42

$$F_{Brake} = \frac{500}{2} \times 9.81 = 2452.5\ N$$

$$T = F_{Brake} r = 2452.5\ N \times 9.81 = 279.59\ N.m$$

$$F_{Clamp} = \frac{T}{r_{pad} \mu n} = \frac{279.59}{0.05 \times 0.42 \times 2} = 6656.9\ N.m$$

The estimated load was was achieved using two 16 mm diameter pistons with hydraulic pressure and a 5:1 lever assist that can allow for sufficient margin for pad wear and temperature variation. The following Figure 2 shows the final rendered design of the final assembly in 3D Experience.

Figure 2: Final Render of Aircraft Brake pad System

The following Figure 3 shows the render of the break pad assembly with pistons and axle designed for the aircraft braking system.

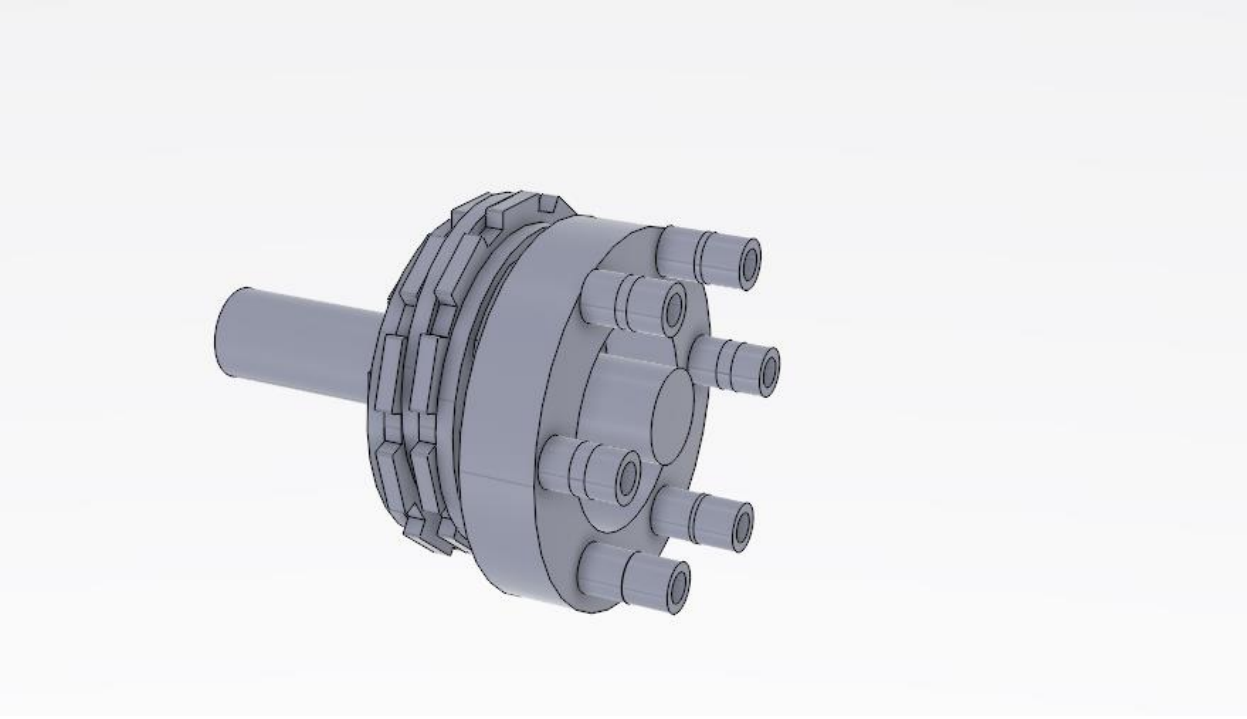

Figure 3: Render of Designed Axle, Dual Break Pad and Piston System

The following Figure 4 shows the Excel based file used for calculation of parts sizes and dimensions for modelling purposes.

	Parameter	Value	Units
2	Aircraft Mass (kg)	500	kg
3	Number of Braked Wheels	2	-
4	Required Deceleration (m/s²)	9.81	m/s²
5	Tyre Radius (m)	0.114	m
6	Brake Pad Friction Coefficient (μ)	0.42	-
7	Effective Pad Radius (m)	0.05	m
8	Piston Diameter (m)	0.016	m
9	Pilot Force (N)	500	N
10	Lever Ratio	5	-
11	Master Cylinder Force (N)	2500	N
12	Piston Area (m²)	0.000201	m²
13	Hydraulic Pressure (Pa)	12437812	Pa
14	Clamp Force per Piston (N)	2503	N
15	Total Clamp Force (N)	5006	N
16	Brake Torque (Nm)	285.34	Nm
17	Safety Factor	1.2	-
18	Adjusted Clamp Force (N)	6007.2	N
19	Pad Contact Area (cm²)	12	cm²
20	Specific Pressure on Pads (MPa)	0.5	MPa
21	Caliper Mass	180	
22	Pad Mass	60	
23	Piston Mass	90	
24	Axle Mass	240	
25	Bearings + Fasteners Mass	100	
26	Total Mass	670	
27			
28			
29	**Parameter**	**Value**	**Units**
30	Wheel Hub Inner Diameter	0.03	m
31	Axle Outer Diameter	0.02985	m
32	Radial Clearance (Hub - Axle)	0.00015	m
33	Caliper Cavity Diameter	0.018	m
34	Piston Clearance in Caliper	0.0002	m
35	Pad Thickness (New)	0.008	m
36	Pad Wear Allowance	0.002	m

Figure 4: Screenshot of Calculations on EXCEL

The following Figure 5 shows the screenshot of tree expanded to feature level on the parts designed.

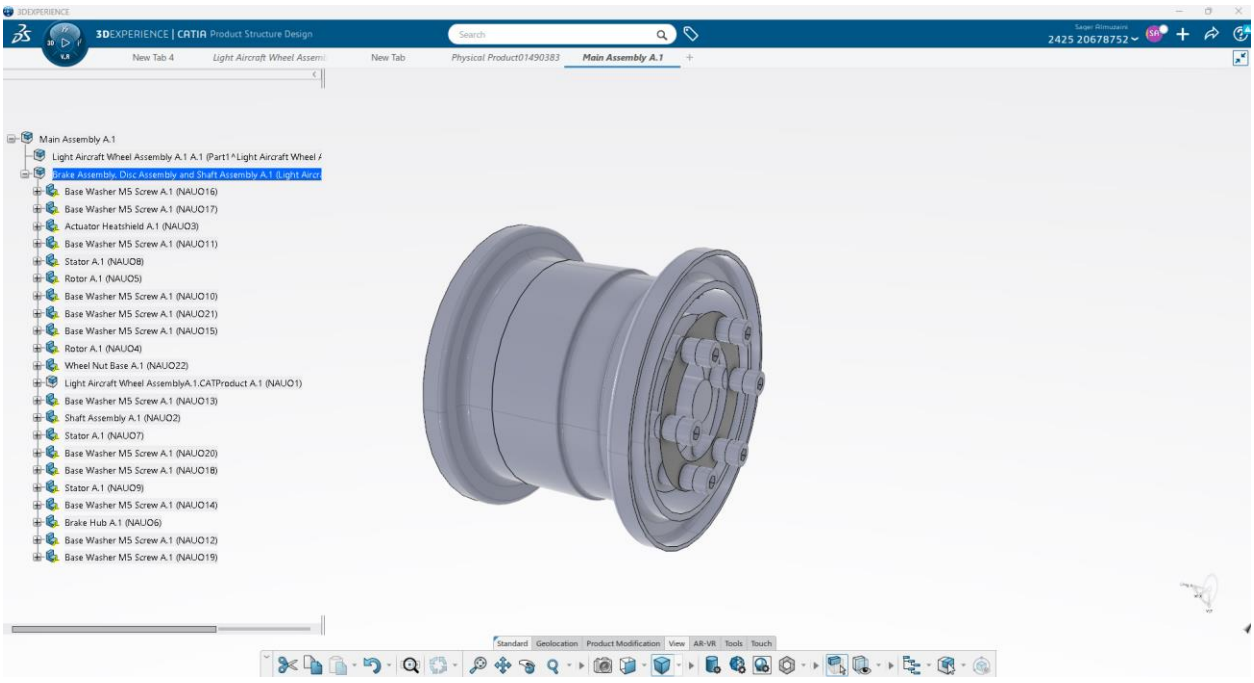

Figure 5: Screenshot of Expanded Tree