МІНІСТЕРСТВО ОСВІТИ ТА НАУКИ УКРАЇНИ

НАЦІОНАЛЬНИЙ АВІАЦІЙНИЙ УНІВЕРСИТЕТ

Кафедра конструкції літальних апаратів

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри
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«_____» ___________ 2021 р.

ДИПЛОМНА РОБОТА

(ПОЯСНЮВАЛЬНА ЗАПИСКА)
ЗДОБУВАЧА ОСВІТНЬОГО СТУПЕНЯ
"БАКАЛАВР"

Тема: «Аванпроект дальньомагістрального пассажирського літака пассажироміскістью 364 людини»

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Київ 2021

MINISRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
Department of Aircraft Design

APPROVED
Head of Department Profe
ssor, Dr. of Sc.
_________S.R. Ignatovych
«___» _______ 2021

DIPLOMA WORK

(EXPLANATORY NOTE)
OF EDUCATIONAL DEGREE

«BACHELOR»

Theme: «Preliminary design of a long-range passenger aircraft with a 364 passenger capacity»

Performed by: **__________ A. A. Turabi**

Supervisor: PhD, associate professor **__________ S.S. Yutskevych**

Standard controller: PhD, associate professor **__________ S.V. Khyzhnyak**

Kyiv 2021

NATIONAL AVIATION UNIVERSITY

Aerospace Faculty

Department of Aircraft Design

Educational degree «Bachelor»

Major 134 "Aviation and space rocket technology"

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Head of Department Profe ssor, Dr. of Sc.
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«___» _______ 2021

TASK

bachelor diploma project

TURABI ALI

1. Theme: **«** Preliminary design of the long-rang aircraft with 364 passenger in 4 classes configuration »

Confirmed by Rector's order from 21.05.2021 year № 815/ст.

2. Period of work execution: from 24.05.2021 year to 20.06.2021 year.

3. Work initial data: cruise speed V_{cr}= 880 km/h, flight range L = 8600 km, operating altitude H_{op} = 10600 km.

4. Explanatory note argument: introduction; design part: selection and justifucation of the aircraft layout, selection of initial data; the computational part: main parts geometry and aerodynamic estimation, choice of engine, airplane layout, position of the center of gravity, special part: description, calculation and installation of the airbrake flaps.

5. Graphical materials list: general view of the airplane (A1×1); layout of the airplane (A1×1); drag devices (A1×1).

6. Calendar Plan

Task	Execution period	Signature
Task accepting, statistical data processing.	24.05.2021 – 30.05.2021	
take-off mass calculation.	29.05.2021 – 30.05.2021	
centering calculation.	31.05.2021 – 01.06.2021	
Graphical design of the aircraft and its layout.	01.06.2021 – 06.06.2021	
Procedure for air brakes installation and checking.	06.06.2021– 16.06.2021	
Completion of the explanation note.	16.06.2021 – 19.06.2021	

7. Task issuance date: 24.05.2021

Diploma work supervisor ____________ S.S. Yutskevych

Task for execution is given for ____________ A.A. Turabi

Abstract

Explanation regard to diploma work « Preliminary design of a long-range passenger aircraft with 364 passenger capacity » contains:

57 sheets, 10 figures, 12 tables, 16 references and 3 drawings

Object of design is design of the long-range aircraft with 364 passenger capacity.

Purpose of diploma work is the design of the airplane preliminary design and characteristic.

The process of development is analysis of the prototypes and selections of the most progressive involve decisions.

The diploma work has drawings of project of the long-range airplane with 364 passenger capacity, calculations and drawings of the aircraft layout.

DEVELOP, CABIN LAYOUT, PASSENGER AIRPLANE, CENTER OF GRAVITY CALCULATION, PASSENGER SECESSION, AIR BRAKE, LANDING SAFETY, HYDRAULIC SYSTEM.

Format	№	Designation	Name	Quantity	Notes
			<u>General documents</u>		
A4	1	NAU 21 10T TT	Task of work	1	
	2		Long-range passenger aircraft	2	
A1		NAU 21 10T 00 00 00 45 GV	General view		
A1		NAU 21 10T 00 00 00 45 AL	Fuselage layout		
A4	3	NAU 21 10T 00 00 00 45 EN	Long-range passenger aircraft	57	
			Explanatory note		
A1	4	NAU 21 10T 00 00 00 45 DD	<u>Documentation for assembly units</u>	1	
			Drag devices		

Ch.	Sheet	Doc.№	Sign.	Date	NAU 21 10T 00 00 00 10 EN			
Performed by	Turabi A.A				List of diploma work	List	Sheet	Sheets
Supervisor	Yutskevych S.S.							
Adviser						AF 402 134		
Stand. contr.	Khyzhnyak S.							
Head. of dep.	Ignatovych S.							

CONTENT

Department of Aircraft Design				*NAU 21 10T 00 00 00 45 EN*	
Performed by	*Turabi A.A.*			*Content*	*List* / *Sheet* / *Sheets*
Supervisor	*Yutskevych S.S.*				
Adviser					*AF 402 134*
Stand. contr.	*Khizhnyak S.V.*				
Head of Dep.	*Ignatovych S.R.*				

Abbreviation List

Introduction

During the last time we can significantly recognize the rising of the capacity of passenger amount, notably to new long distances , which dramatically increased the need for huge long-range aircrafts. therefore was a need for aircraft to transportation on long distances, which as it is more economical, more comfortable and faster than other vehicles. To provide cost-effective operation with high regularity and reliability of flights in a highly competitive world market, new civil aviation aircraft are needed that meet the requirements of the international air transport organization, namely:

-Flight safety;

- Increasing comfort operation;

- Reducing emissions of harmful gases, and others.

The projected plane must also meet the following requirements:

- Comfortable salon that meets the highest compfort;
- work in different temperature phase;
- Ease and reliability of use;

The aim of the diploma work is to create an aircraft designed to carry 364 passengers of various classes and their luggage on long routes.

1.DESIGN PART

1.1. Analysis of prototypes and short description of designing aircraft

1.1.1. Choice of the projected data

The selection of prime design data of the airplane is the multi-dimensional integrational task, aligned at form a "look" promising airplane. In its format mean the all complex flighttechnical, geometrical, weight, economic and aerodynamic characteristics. In forming the "Aspect of the plane" in the 1 stage is large used statistics ways transfers, such as statistical and aerodynamical dependence. The 2 phase uses a complex aerodynamical calculation; airplane due to formulas weight of aggregates calculations, experimentally

Airplane prototypes, taking form aircraft were in class 301-519 passengers in 4 classes' configuration. Such as Boeing 777-300ER, Boing 747-8 and Airbus 380-800 will be taking to account in this project.

Prototypes are presented in table 1.1.

Table 1.1. – Operational-technical data of prototypes; [2-4]

PARAMETER	PLANES		
	B777-300ER	B 747-8	A 380-800
The purpose of airplane	Passenger	Passenger	Passenger
Crew/flight attend. Persons	2/2	2/2	2/2
Maximum take-off weight, m_{tow}, kg	351500	442252	560000
Most pay-load, $m_{к.max}$, kg	68500	76067	83914
1	2	3	4

1	2	3	4
Passenger's seat	301	364	519
Range $m_{к.max}$, km	14490	14,320	14,800
Take off distance $L_{зл.д.}$, m	3,200	3190	2900
Number and type of engines	2xGE90-115BL1	4xGEnx	4xTrent900
The form of the cross-section fuselage	circular	Double deck	Double deck
Sweepback on 1/4 chord, ^{0}	31.64	34	33,5

1.1.2. short description of the main parts of the aircraft

The aircraft is a low-wing monoplane with bypass turbojet power plant placed on the wing paylone, tricycle landing, front single-strut L.G. and 4 main gears two of wich located under the wing and other 2 is located under fuselage.

Fuselage with double-deck cross section. Empenage has a conventional structure with vertical stabilizer installed on the fin. The rudder and elevators are aerodynamically balanced.

1.1.3. Fuselage

The fuselage all metal, beam stringer structure (semi-monocoque type). This structure is distinguished by the a relatively thick skin, supported by stringers and frames.

The fuselage, reasonably is to combine the good advantages ratio of shape to length of parts, with a minimum possible of resistance and a large critical value of the number M which reduce the number of stress on the aircraft structure.

In the cockpit there are installed two seats for the first pilot and second pilot. There is also installed a seats for flight attendant and box with first aid helps, also fire extinguisher and ax for emergency situation.

The first pilots seat is located on the left side of the crew cabin and the second pilots seat is located on the right side of the fuselage.in front pilots is located the instrumental panels and between the pilots an standard pilot console. Over the pilots seats of the cockpit, is installed an upper electric switchboard.

There are windows to the left and right of the salons, and emergency exits on the left and right sides. There are windows to the left and right of the salons, and emergency exits on the left and right sides. Luggage racks are located along the cabin on both sides and in the middle of the fuselage for storing personal belongings of passengers, and general interior ceiling lighting is located on the sides and in the lower part of the baggage section.

The hermetic part of the fuselage, the following rooms and compartments are located: the chassis front landing gear (leaking), front cargo section and the rear cargo section, also technical section. Front and rear cargo bays - hermit disease, each of them consist of hatch on the right and equipped with a container blocking equipments.

The prime force elements of the aircraft fuselage are stringers, frames, chassis longitudinal beams of the front awning support, and skin.

1.1.4. Wing

The wing has a coffered structure, swept in plan. It consists of a central plane and two detachable wing sections connected to the ribs. On the wing are attached 2 of the main legs of the chassis , also ailerons and aerodynamic partitions are installed.

The front part of the wing is equipped with an air thermal and electro thermal de-icing device. Warm air in the nose of the center section is supplied from the compressors of aircraft engines.

The wing consists of a longitudinal and transverse set and a skin. The forefoot and feathering of the wing perceive just local air loads and send them to the caissons.

1.1.5. Empennage

The empennage is swept, convitional construction, consists of vertical and horizontal plumage.
Vertical plumage includes fin and rudder, horizontal plumage - elevator and stabilizer.

The plumage has the sweep back angel greater than sweep pf the wing, so its mean that there is no different between the aerodynamic characteristics of the empennage then the aerodynamic characteristics of the wing by rising the M number. A large vertical tail swing is also suitable, because at the same time, the horizontal tail efficiency is increased by increasing its shoulder.

The vertical and horizontal tail profile is symmetrical. Symmetrical profile of movement of the same nature of aerodynamic drag when the direction deviates in different directions and, moreover, less drag.

1.1.6. Crew cabin

The configuration of working local pilots ensures that any of them are able to control the aircraft safely. The stability and control characteristics of aircraft, the design, characteristics and automation of flight and navigation equipment and on-board systems, the composition and configuration of the display equipment ensure that the pilots fulfill their functional obligations without warning of the current load standards.

The application of the tapered windshield of the cockpit fairings provides good visibility for the pilots and meets the requirements for flying under the expected conditions. There is a probability of automatic and not automatic control by any of pilot.

The placement of instruments and light alarms on the pilot's console is carried out in accordance with the requirements of the annual validity standard. On the visor of the control panel in the zone of maximum reach and views of the located operatively used control panels for command radio stations and automatic control systems.

On the upper panel control of on board systems are located fuel, hydraulic, anti icing, air conditionings, power supply, APU and engine starter, fire extinguishing switches and a board of the warning alarm system.

On the central pilot panel not only traditionally established control levers engines are placed, but also there are panels of the navigation and landing equipment.

1.1.7. Passenger cabin

The furnishing of passenger on the aircraft provides necessary comforts on the plane. It consist of adjustable pilots seats, flight attendant seats and passengers chairs; lights and buffet and lavatories.

In passenger cabin exists 13 lavatories and the area of each one consist of 1,5 meter squar.

There is a tank with water and technical liquid in the lavatory. The lavatory is equipped with a water vacuum.

1.1.8. Control system

The main control is the steering wheel. With the help of it, we can control the aircraft in roll and pitch. In order to raise the nose of the aircraft, you must pull the control wheel towards you. This movement of the aircraft is called pitching. If you push the steering wheel on yourself, then the nose will go down. This is called a dive.

When the control wheel is rotated to the left or to the right, the aircraft rotates around its longitudinal axis in the same direction, i.e. increases or decreases roll.

For yaw control (rotation of the aircraft around the vertical axis), pedals are used. When you press the right pedal, the nose of the aircraft will also turn to the right. Basically, the pedals are used during takeoff and landing on the takeoff run and the runway run.

The third important governing body is the engine control levers, or ore for short. They regulate the thrust of the engines, and, accordingly, the speed of our flight. You can control the thrust manually, but most often in flight, an autothrottle is used, it controls the levers automatically and maintains a given speed.

Other controls, terms and abbreviations

In this manual, you will come across various abbreviations, terms, abbreviations, unfamiliar controls, so first let's decide where they are and what they mean.

1.1.9. Landing gear

Retractable, with a steerable front support. There are 4 main supports. Two of them are installed under the fuselage at the trailing edge of the wing, they are retracted forward into the ventral niche, the other two under the wing, retracted inward. The front support retracts forward into the fuselage. Four-wheeled trolleys are installed on the main supports, two wheels on the bow. All wheels with anti-slip disc brakes.

1.2. Geometry determinations for the main parts of the airplane

The layout of the aircraft consists of drawing up the relative position of its parts and structures, as well as all types of cargo (baggage ,passenger, cargo, fuel, etc.).

The choice of the configuration of the composition and parameters of the aircraft is aimed at maximum compliance with operational requirements.

1.2.1. Wing geometry determination

Geometrical characteristics of the wing are determined from the take of weight m_0 and specific wing load P_0.

Wing area is: $S_{w=} \frac{m_o \cdot g}{P_o} = \frac{331079 \cdot 9.8}{6.477} = 500.93m^2$

Relative wing extensions area is 0.1

Wing span is: l=$\sqrt{S_w \cdot \lambda_w}$=$\sqrt{500.937 \cdot 7}$= *59.216m*

Root chord is: $b_0 = \frac{2 \cdot A_w . \eta_w}{(1+\eta_w) \cdot l} = \frac{2 \cdot 500.937 \cdot 3.22}{(1+3.22) \cdot 59.216} = 12.91m$

Tip chord is: $b_t = \frac{b_0}{\eta_w} = \frac{12.91}{3.22} = 4.009m$

Maximum wing width is determined in the forehead i-section and by its span it is equal: $C_i = C_w \cdot b_t = 0.11 \cdot 4.009 = 0.44m$

On board chord for trapezoidal shaped wing is:

$b_{ob} = b_o \cdot \left(1 - \frac{(\eta_w - 1) \cdot D_f}{\eta_w \cdot l_w}\right) = 12.91 \cdot \left(1 - \frac{(3.22-1) \cdot 7.40}{3.22 \cdot 59.216}\right)$ =11.79m

At a choice of power scheme of the wing determine quantity of longerons and its position, and the places of wing portioning.

On the modern aircraft use xenon double – or triple – longeron wing; longeron wing is common to the light sport, sanitary and personal aircrafts. determine the geometrical method of mean aerodynamic chord determination

(Figure 1.2.). Mean aerodynamic chord is equal: $b_{mac} = 9.23m$

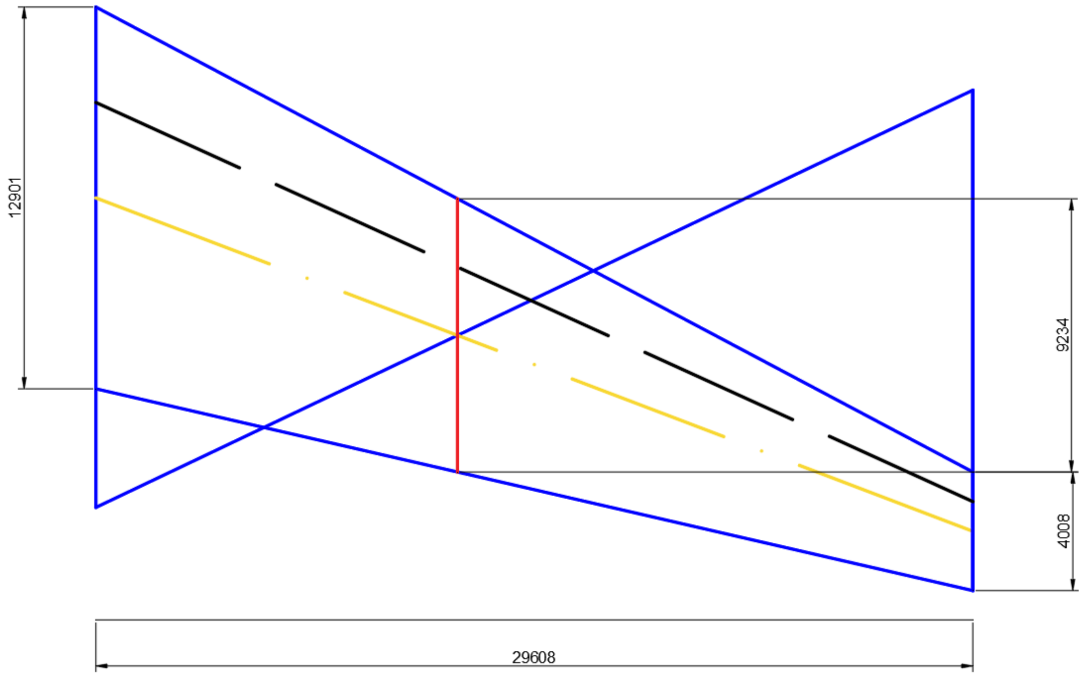


Figure 1.2. – Determination of mean aerodynamic chord

After determination of the geometrical characteristics of the wing we come to the estimation of the ailerons’ geometrics and high-lift devices.

Ailerons geometrical parameters are determined in next consequence:

Ailerons’ span:

$$l_{ai} = 0.375 \cdot \frac{l_w}{2} = 0.375 \cdot \frac{59.216}{2} = 9.79m;$$

Aileron area:

$$S_{ai} = 0.065 \cdot \frac{S_w}{2} = 0.065 \cdot \frac{500.937}{2} = 16.28m^2$$

It is not necessary and convenient to increase lail and bail beyond the recommended values.

With an increase in lail more than a specified value, an increase in the coefficient of el.

With a change in the bow, the xenon width decreases.

In the airplanes of the 3th generation is a tendency to reduce relative wing span and ailerons space.

Aerodynamic compensation of the aileron.

Axial $S_{axinail} \leq (0.25 \ldots 0.28)\ S_{ail} = 0.27 \cdot 16.28 = 4.39 m^2$

Inner axial compensation $S_{inaxinail} = (0.3..0.31)\ S_{ail} = 0{,}31 \cdot 16{,}28 = 5{,}04 m^2$

Area of ailerons trim tab.

For four engine airplane: $S_{tail} = (0.07 \ldots 0.08) S_{ail} = 0.07 \cdot 16.28 = 1.13\ m^2$

Range of aileron deflection

Upward $\delta'_{ail} \geq 30$ or 25 degree

Downward $\delta''_{ail} \geq 20$ or 15 degree

The purpose of determining the geometric parameters of the lifting devices is to ensure the take-off and landing coefficients of the lifting wing adopted in the previous calculations with the selected speed of the lifting devices and the type of airfoil.

Before performing the following calculations, it is necessary to select the type of profile for high-altitude vehicles, value of lift coefficient $C_{y\max bw}$ and calculate necessary rice for next coefficient $C_{y\max}$ for the high lift devices outlet by the formula: $\Delta C_{y\max} = (\frac{C_{y\max l}}{C_{y\max bw}})$.

Where $C_{y\max l}$ is the coefficient of lift in the landing configuration of the wing necessary when choosing an aircraft option. (calculated due to the selecting the plane parameters).

In the now days constructions the number of the relative chords of high-lift devices:

b_{sf} = 0.25..0.3 – for the split edge flaps;

b_f = 0.28..0.3 – one slotted and two slotted flaps;

b_f = 0.3..0.4 – for three slotted flaps and Faylers flaps;

b_s = 0.1..0.15 – slats.

high-lift devices productiveness (C^*_{ymaxl}) increase relative to the wing span, by high-lift devices serviced, then it require to obtain the greater span of high lift devices ($l_{hld} = l_w - D_f - 2l_{ail} - l_n$) due to use of flight spoiler

Throughout the selection of constructlly stronger design, hinge fitting schemes and kinematics. It requireto use the statistics and experience of domestic and foreign aircraft construction.

1.2.2. Fuselage layout

When selecting the size and the shape fuselage cross section, we must proceed from the requirements of aerodynamics (streamlining and cross-section).

According to subsonic passenger airplane and cargo airplane (V < 800 km/h) the characteristic impedance does not affect it. Therefore it require to selecting from a list of values of the frictional resistance Cxf and the resistance of the profile Cxp.

In transonic and subsonic flights, the shape of the nose of the fuselage affects the wave drag Cxw. The use of a round shape of the nose of the fuselage, which reduces its wave drag.

For transonic airplanes fuselage nose part has to be:

$l_{nfp} = 2.1 \cdot D_f = 2.1 \cdot 7.40 = 15.54$m

Besides taking into account aerodynamic requirements when choosing a cross-sectional shape, it is necessary to take into account the requirements for strength and layout.

For cargo airplane, aerodynamics are not so necessary when choosing the shape of the fuselage, and the shape of the cross-section can be close to rectangular.

Geometric parameters include:

- fuselage diameter Df;
- fuselage length l_f ;
- fuselage aspect ratio λ_f ;
- fuselage nose part aspect ratio λ_{np} ;
- tail unit aspect ratio λ_{TU} .

The fuselage length is determined taking into account the aircraft layout, its layout and features of the aircraft's center of gravity, as well as the conditions for ensuring the landing angle of attack αland.

Fuselage length is equal: 76.25- from prototype

Fuselage nose part aspect ratio is equal: $\lambda_{fnp}= \frac{l_{fnp}}{D_f} = \frac{15.54}{7.40} = 2.1$

In passenger and cargo aircraft, the middle fuselage is primarily determined by the dimensions of the passenger compartment or cargo compartment.

One of the primer parameter that determine the middle section of passenger aircraft is the height of the passenger compartment.

For long range airplanes we may take the height as:

- h1=1.9 m;
- passage width bp=0.6 m;
- the distance from the window to the flour h2=1m;
- luggage space h3=0.6...0.9m.

For long range airplanes correspondingly:

- the height as: h1=1.9m;
- passage width bp=0.6m;
- the distance from the window to the flour h2=1m;
- luggage space h3=0.9...1.3m.

I choose the next parameters:

Cabin height is equal:

$H_{cabupper\ deck} = 1.48 + 0.17 \cdot B_{cab}$ = 1.48 + 0.17 · 3.900 = 2.14m

$H_{cab\ main\ deck}$ = 0.256 + 0.383 · 6.570 = 2.77m

As design its convenient to select circular cross-section, so in this case it'll be the most durable and the lightest But for accommodating passengers and cargo, this form is not always the best selection. In general, one of the best choice is to use the combination of intersection of two circles or an oval fuselage shape. We must understand that the oval shape is not easy in production, so the top and bottom panels will flex due to the additional pressure and require additional bilge beams and other structural reinforcements.

For an economy cabin with a single row seating arrangement (3+4+3) determine the appropriate width of the cabin

$B_{cab\ main} = n_3 b_3 + n_4 b_4 + n_n b_n + 2\delta$= 2 · 1710 + 1 · 2280 + 2 · 567.35 + 2 · 50 =
= 6934.7mm

$B_{cab\ upper} = 2 \cdot 1455.5 + 1 \cdot 821 + 2 \cdot 268.5 = 4269 mm$

Where:

$n_3 n_4$ – Number of chair block consist of 3 and for chairs, mm

n_n – Number of aisles

$b_n -$ width of aisles mm

δ – Length between chair and fuselage inside wall

The length of passenger cabin is equal:

$L_{cabin\ upper\ deck} = L_1 + (n_{raws} - 1) L_{seatpitch} + L_2$ = 1300 +(9 – 1) 1080 +
+ 250 = 10190mm

$L_{cabin\ main\ deck} =$ 63.25m – taken from prototype

1.2.3 Luggage section

The area of cargo compartment is defined:

$$S_{cargo} = \frac{M_{bag}}{0.4K} + \frac{M_{cargo\&mail}}{0.6K} = \frac{20.364}{0.4 \cdot 600} + \frac{15.364}{0.4 \cdot 600} = 45.49 (m^2);$$

Cargo compartment volume is equal:

$$V_{cargo} = V \cdot n_{pass} = 0.2 \cdot 364 = 72.8 (m^3);$$

Luggage compartment design is similar to the prototype.

1.2.4 Galleys and buffets

International standards rudiments for long range aircraft must be designed 1 ... 2 kitchen depended of amount of passengers. Kitchen cabinets should be located at the door, ideally between the cockpit and passenger section or cargo separate doors. Snacks and food must not be placed next to the lavatory or connected to the wardrobe.

Volume of buffets(galleys) is equal:

$$V_{gally} = (0.1 \ldots 0.12)N_{pass} = 0.12 \cdot 364 = 43.68m^3$$

Area of buffets(galleys) is equal:

$$S_{gally\,main\,deck} = \frac{V_{gally}}{H_{cab}} = \frac{43.68}{2.772} = 15.75m^2$$

$$S_{gally\,upper\,deck} = \frac{43.68}{2.143} = 20.38m^2$$

Amount of meal for each passenger for breakfast, lunch and dinner – 0,8 kg;
tea and water – 0,4 kg;

If the meal was organized once, she is given set No. 1 weighing 0.62 kg. Passengers get food every 3.5-4 hours of the flight.

Buffet design similar to prototype.

1.2.5 Lavatories

The amount of lavatories is calculated by the amount of passengers and the duration of the flight:

with t> 4:00 one toilet for 40 passengers,

at t = 2 ... 4 hours and 50 passengers

t <2 hours to 60 passengers.

The amount of toilet according to the prototype aircraft and it is equal:

$n_{lav} = 13$

Area of lavatory:

$S_{lav} = 1.5m^2$

Width of lavatory =1m. Toilets design similar to the prototype.

1.2.6 Determinations of perimeters of empennage

One of the important problem of the aerodynamic scheme is the choice of the placement of the tail assembly. To ensure longitudinal stability during overloads, its center of gravity must be located in front of this aircraft, the distance between these points, associated with the average value of the aerodynamic wing chord, determines the longitudinal stability index.

$$m_x^{Cy} = \bar{x}_T - \bar{x}_F < 0$$

Where m^{Cy}_x –is the moment coefficient; $x_{T.}$ x_F- center of gravity and focus coordinates. If m^{Cy}_x=0, than the plane has the neutral longitudinal static stability, if m^{Cy}_x>0, than the plane is statically instable. In the normal aircraft scheme (tail unit is behind the wing), focus of the combination wing – fuselage during the install of the tail unit of moved back.

Static coefficient of static moment:

horizontal Ahtu, vertical Avtu, given in the table with typical shoulder correlations Htu and Vtu. Using the table, we can find the first approach to determining the geometric parameters.

Determination of the tail unit geometrical parameters

Area of vertical tail unit is equal:

$$S_{VTU} = \frac{l_w S_w}{L_{VTU}} \cdot A_{VTU} = \frac{59.216 \cdot 500.937}{30} \cdot 0.12 = 118.65 m^2$$

Area o horizontal tail unit is equal:

$$S_{HTU} = \frac{b_{mac} S_w}{L_{HTU}} \cdot A_{HTU} = \frac{9234 \cdot 500.937}{32.50} \cdot 0.8 = 113.86 m^2$$

The Lhtu and Lvtu values depend on several factors. First on their definition: the length and tail section, sweep and position of the wing, conditions of stability and controllability of the aircraft.

Determination of the elevator area and direction:

Altitude elevator area:

$$S_{el} = 0.2765 \cdot S_{HTU} = 0.2765 \cdot 133.862 = 31.48 m^2$$

Rudder area:

$$S_{rud} = 0.2337 \cdot S_{VTU} = 0.2337 \cdot 118.653 = 27.72 m^2$$

Choose the area of aerodynamic balance.

Elevator balance area is equal:

$$S_{el} = 0.2765 \cdot S_{HTU} = 0.2765 \cdot 133.862 = 31.48 m^2$$

Rudder balance area is equal:

$$S_{rud} = 0.2337 \cdot S_{VTU} = 0.2337 \cdot 118.653 = 27.72m^2$$

The area of altitude elevator trim tab:

$$S_{te} = 0.08 \cdot S_{el} = 0.08 \cdot 31.482 = 2.52m^2$$

Area of rudder trim tab is equal:

$$S_{tr} = 0.06 \cdot S_{rud} = 0.06 \cdot 27.729 = 1.66m^2$$

Root chord of horizontal stabilizer:

$$b_{oHTU} = \frac{2 \cdot S_{HTU}\eta_{HTU}}{(1+\eta_{HTU})l_{HTU}} = \frac{2 \cdot 113.862 \cdot 0.265}{(1+0.265) \cdot 22.08} = 2.16m$$

Tip chord of horizontal stabilizer is:

$$b_{tHTU} = \frac{b_{oHTU}}{\eta_{HTU}} = \frac{2.160}{0.265} = 8.15m$$

Root chord of vertical stabilizer is:

$$b_{oVTU} = \frac{2 \cdot S_{VTU}\eta_{VTU}}{(1+\eta_{VTU})l_{VTU}} = \frac{2 \cdot 118.653 \cdot 0.330}{(1+0.330) \cdot 10.16} = 5.79m$$

Tip chord of vertical stabilizer is:

$$b_{tVTU} = \frac{b_{oVTU}}{\eta_{VTU}} = \frac{5.797}{0.330} = 17.56m$$

1.2.7 Landing gears

At the initial design stage, when the position of the center of gravity of the aircraft is determined and there is no general view of the aircraft, only part of the landing gear parameters can be determined.

Main wheel axel offset is:

$e = 0.2673 \cdot b_{mac} = 0.2673 \cdot 9.234 = 2.47m$

With a great axial displacement of the wheels, it is difficult to lift the front landing gear during takeoff, and with a small axial displacement, the aircraft may fall on the tail, when the rear part of the aircraft is loaded first.

Landing gear wheel base comes from the expression:

$B = 0.4526 \cdot L_f = 0.4526 \cdot 76.25 = 34.51m$

The nose support carries 6...10% of aircraft weight.

Front wheel axial offset will be equal:

$d_{ng} = B - e = 34.510 - 2.468 = 32.04m$

Wheel track is: $T = 0.6072 \cdot B = 0.6072 \cdot 34.510 = 20.95m$

Under the condition of preventing lateral drooping of the nose, the value of K most be:

$> 2H$,

where H – is the distance from runway to the center of gravity.

The wheels for the chassis are selected according to the size and running load on it from the take-off weight; for the front support we also take into account the dynamic load.

The type of pneumatics (balloon, hemisphere, arched) and the pressure in it is calculate by the length of the runway to be used. We mount brake discs on the main wheel, and sometimes on the front.

The load on the wheel is determined:

$K_g = 1.5...2.0$ – dynamics coefficient.

Nose wheel load is equal:

$$P_{NLG} = \frac{(9.81 \cdot e \cdot k_g \cdot m_o}{(B \cdot Z)} = \frac{(9.81 \cdot 2.468 \cdot 2 \cdot 331079)}{(34.510 \cdot 2)} = 232274.127N = 52217.30\text{lbs}$$

Main wheel load is equal:

$$P_{MLG} = \frac{(9.81 \cdot (B-e) \cdot m_o)}{(B \cdot n \cdot Z)} = \frac{(9.81 \cdot (34.510-2.468) \cdot 331079)}{(34.510 \cdot 16 \cdot 4)} = 47119.9\text{N} = 10592.979189\text{lbs}$$

Table 1.2. – Aviation tires for designing aircraft

H49x19.0-22 (DR26020T)

Main gear		Nose gear	
Tire size	Ply rating	Tire size	Ply rating
H49x19. 0-22	32	H49x19. 0-22	32

1.2.8 Engine selection

The GEnx is a derivative of the GE90 with a fan diameter of 282 cm for the 787 and 266 cm for the 747-8. To reduce weight, it is equipped with 18 composite fan blades, a composite fan casing and a titanium-aluminum stage 6 and 7 low pressure turbine blades. Fuel efficiency is 15% improved over CF6, with a bypass ratio of 9.0: 1 and an overall pressure ratio of up to 58.1: 1. The 10-stage high pressure compressor runs quieter, aided by larger and larger displacement. efficient fan blades.

It stays on the wing 20% longer, uses 30% fewer parts to reduce maintenance costs, and has a counter-rotating design. The Lean TAPS combustion chamber reduces NOx emissions with the required pressure loss and counterflow margin.

To decrease maintenance costs and rising engine life, spools with fewer parts are achieved by using blisk in some stages, fewer blades in other stages, and using fewer stages; the internal temperature of the engine is reduced by more efficient cooling methods, and the removal of debris inside the low pressure compressor protects the high pressure compressor.

Table 1.3. Examples of application

Model	Thrust	Bypass ratio	Dry weight
General Electric GEnx	66,500 lbf (296 kN)	8.0	12,397 lb (5,623 kg)

1.3 Determination of the aircraft center of gravity position

1.3.1 Determination of centering of the equipped wing

The weight of an equipped wing includes the weight of its structure, the weight of the equipment located in the wing, and the weight of the fuel. Regardless of the attachment point (to the wing or to the fuselage), the main landing gear and A-pillars are included in the equipped wing mass register. The register of masses includes the names of objects, the masses themselves and the coordinates of their centers of gravity. The origin of the given position of the weight centers is selected by the design of the forward point of the mean aerodynamic chord (MAC) for the surface XOY. For the end part of the aircraft, positive values of the coordinates of the centers of mass are taken.

An indicative list of mass objects for an aircraft with engines located under the wing included the names given in Table 3.1. names given in table 3.1. Aircraft weight 91295 kg. The coordintes of the center of force of the equipped wing are determined by the formulas:

$$X_w^{/} = \frac{\Sigma m_i^{/} x_i^{/}}{\Sigma m_i^{/}}$$

Table 1.4. - Trim sheet of equipped wing

N	Name	Mass		C.G. coordinates x_i (m)	Moment $m_i x_i$ (kgm)
		Units	total mass m_i (kg)		
1	Wing (structure)	0,0918	30393,05	4.15	126292,25
2	Fuel system	0,0141	4668,21	4,15	19397,83
3	Control system, 30%	0,00123	407,22	5,54	2256,04
4	Electrical equip. 10%	0,00205	678,71	0,92	626,72
5	Anti-icing system 50%	0,0102	3377	0,92	3118,32
6	Hydraulic system, 70%	0,00917	3035,99	5,54	16820,62
7	Engine 1- fuel system	0,03596	11905,60	-4,09	-48765,34
8	Engine 2- fuel system	0,03596	11905,60	4,78	56968,30
9	Equipped wing without fuel and LG	0,20047	66371,40	2,66	176714,74
10	Fuel	0,37021	122568,75	3,84	470700,79
11	Equipped wing	0,62652	192010,25	3,35	643627,32

1.3.2 Determination of centering of the equipped fuselage

The source of the coordinates is selected in the projection of the fuselage on the horizontal axis. The X-axis shows the constructional part of the fuselage. An approximate list of objects for aircraft, the engines of which are installed under the wing, are given in Table 1.5.

The CG coordinates of the FEF are determined by formulas:

$$X_f = \frac{\Sigma m_i^{/} X_i^{/}}{\Sigma m_i^{/}};$$

After we determined the C.G. of fully equipped wing and fuselage, we construct the moment equilibrium equation relatively to the fuselage nose:

$$m_f x_f + m_w (x_{MAC} + x_w^/) = m_0 (x_{MAC} + C)$$

From here we determined the wing MAC leading edge position relative to fuselage, means $\mathbf{X}_{MAC}$ value by formula:

$$X_{MAC} = \frac{m_f x_f + m_w \cdot x_w^/ - m_0 C}{m_0 - m_w} = 35.52 \text{ m}$$

Table 1.5. – Trim sheet of equipped fuselage

№	Objects	Mass		Coordinates of C.G.	Moment (kgm)
		Units	Total (kg)		
1	Fuselage	0,07864	26036,05	38,12	992624,50
2	Horizontal TU	0,00791	2618,83	73,46	192400,56
3	Vertical tail unit	0,00817	2704,91	895540695,6	24223618457 21.37
Equipment					
4	Navigation equipment	0,0026	860,80	4,48	3860,71
5	Anti-icing system, 25%	0,0051	1688,50	61	102998,67
6	Air conditioning system, 25%	0,0051	1688,50	38,12	64374,17
7	Control syst 70%	0,00287	950,19	38,12	36226,25
8	Hydraulic sys30%	0,00393	1301,14	53,37	69448,37
9	Electrical eq, 90%	0,01845	6108,40	38,12	232883,03
10	lining and insulation	0,0064	2118,90	38,12	80783,27
11	Radar	0,0017	562,83	1,17	659,07
12	Air-navig. system	0,0072	84,8	0,80	67,86
13	Radio equipment	0,0013	430,40	4,48	1930,35
14	Instrument panel	0,003	993,23	4,48	4454,66
15	Body LG 45%	0,007587	2511,89	4,49	11283,43

1	2	3	4	5	6
1	2	3	4	5	6
16	Not typical equipment	0,0034	1125,66	38,12	42916,11
17	Additional eq (emergency eq)	0,01	3310,79	38,12	126223,86
18	Oprational items	0,01974	6535,49	38,12	249165,91
19	Seats of pass. economical class (244 seats)	0,004817581	1595	49,93	79644,73
20	Seats of pass. Premium economy class (32 seats)	0,000712821	236	32,42	7653,24
21	Seats of pass. business class (80 seats)	0,002174708	720	17,74	12773,52
22	Seats of pass. first class (8 seats)	0,000338288	112	4,62	518,22
23	Seats of crew (2 seats)	0,00009	30	6,04	181,32
24	Seats of flight attendance (14 seats)	0,00021143	70	38,12	2668,75
Furnishing (Lavatory, Galley/buffet)					
25	Lavatory and galley (1th section) 24%	0,004632	1533,55	7,90	12121,24
26	Lavatory and galley (2th section) 36%	0,006948	2300,33	25,02	57570,53
27	Lavatory (3th section) 8%	0,001544	511,18	34,35	17563,32
28	Galley (4Th section) 16%	0,003088	1022,37	48,37	49455,19
29	Lavatory (5Th section) 16%	0,003088	1022,37	64,86	66311,04
Payload					
30	Baggage/cargo/ mail (1th section)	0,044010901	14571,08	13,69	199594,72
31	Baggage/cargo/ mail (2th section)	0,044010901	14571,08	53,52	779859,04

1	2	3	4	5	6
1	2	3	4	5	6
32	*Crew*	0,000453064	150	6,04	906,6
33	Passengers	0,071463306	23660	31,98	756646,8
34	**Total**	0,37348	123651,58	19590254,61	242 236 188 8 27 906

1.3.3 Calculation of center of gravity positioning variants

The list of object masses for calculating the center of gravity variant is shown in Table 1.6. The parameters for calculating the center of gravity given in table 1.7

Table 1.6. – Calculation of C.G. positioning variants

Name	Mass, kg	Coordinates	Moment
Object	m_i	C.G. M	kgm
Equipped wing without fuel and L.G.	66371,40	38,18	2534492,61
Nose landing gear (extended)	558,19	7,96	4443,82
Wing landing gear (extended)	2511,89	36,85	92585,98
Main Landing (extended)	2511,89	40,14	100830,03
Total fuel	135474,21	39,36	5332847,68
Equipped fuselage without payload	70699,41	39,62	2801119,21
Baggage, cargo, mail (1th section)	14571,08	13,79	201008,11
Baggage, cargo, mail (2th section)	14571,08	54,49	794080,42
Passenger	23660	31,98	756646,8
Crew	150	6,04	906,6
Nose LG (retrected)	558,19	5,99	3345,84

1	2	3	4
1	2	3	4
Wing landing gear (retrected)	2511,89	36,85	92585,98
Main Landing (retrected)	2511,89	38,41	96502,03
Reserved Fuel	122568,75	41,87	5132689,25

Table 1.7. – Airplanes C.G. position variants

№	Variants of the loading	Mass, kg	Moment of the mass, кg*m	Centre of the mass, m	Centering, %
1	Take-off mass (L.G. extended)	331079,20	12618642,01	38,11	29,45%
2	Take-off mass (L.G. retrected)	331079,20	12613532,81	38,09	29,27%
3	Landing waight (L.G. extended)	318173,74	12418483,58	39,03	37,98%
4	Ferry version (L.G. retrected)	278277,03	10861797,47	39,03	37,99%
5	Parking version (L.G. extended)	142652,81	5533152,38	38,78	35,37%

1.4. Conclusion to the project part

In the course of work I receive the following results:

- conceptual design of long-rang airplane for 364 passengers;
- the cabin layout of the long range aircraft with 364 passengers capacity;
-determination of the center of gravity of the airplane;
-determination of the basic geometric parameters of the LG;
-selection of wheels that meet the requirements;
- the nose and main landing gear calculation and design.
- the planning and convenient maintenance of premises;
-the reliability and comfortable design for passengers;
- low noise;

Installation of new composite turbofan engines type General Electric GEnx provides high cruise speed, good thrust-to weight ratio, low noise, low weight economic and lower maintenance cost

The choosing and calculation of the main parts of aircraft is multidimensional task that need the maximum consideration during design, modern aircrafts require modern technology and new days airplane such as boing 747-8 is the one of the leaders between others prototypes the include in them self, modern technologies, comfort design for long rang tripe and the most important is that this aircraft one of the reliable airplane in the word.

2. SPECIAL PART

Air brake system

2.1. Introduction

Currently, civil aviation is the safest form of transport. Nevertheless, aviation accidents and disasters are one of the favorite topics in the media. This leads to the fact many of people afraid to flying by airpalnes

If you go to Wikipedia and look at the statistics of modern air crashes, you can see that the majority of accidents and disasters are associated with the approach of an aircraft.

Also in the previous course, we learned that takeoff and landing are a dangerous moment in flight, according to statistics from the Boing Corporation, 63% of all accidents occur during flight and landing, 14% of accidents occur during takeoff and 49% of them occur during landing, so that means landing is the most dangerous phase of flight
This is the so-called "Collision with the ground in controlled flight", or Controlled flight into terrain, CFIT.

What is the problem of landing an airplane? The fact is that an airplane is a rather fragile structure, and piloting is a rather complicated process, since air is a low-density medium. When approaching, the aircraft must follow the landing glide path with high accuracy in order to get to the beginning of the runway with a certain course and speed. An undershoot leads to damage to the aircraft landing gear and a catastrophe, a long flight leads to the inability to stop movement in time with similar consequences. In addition, the approach process begins at a great distance from the airfield, landing can be carried out in poor weather conditions, etc.

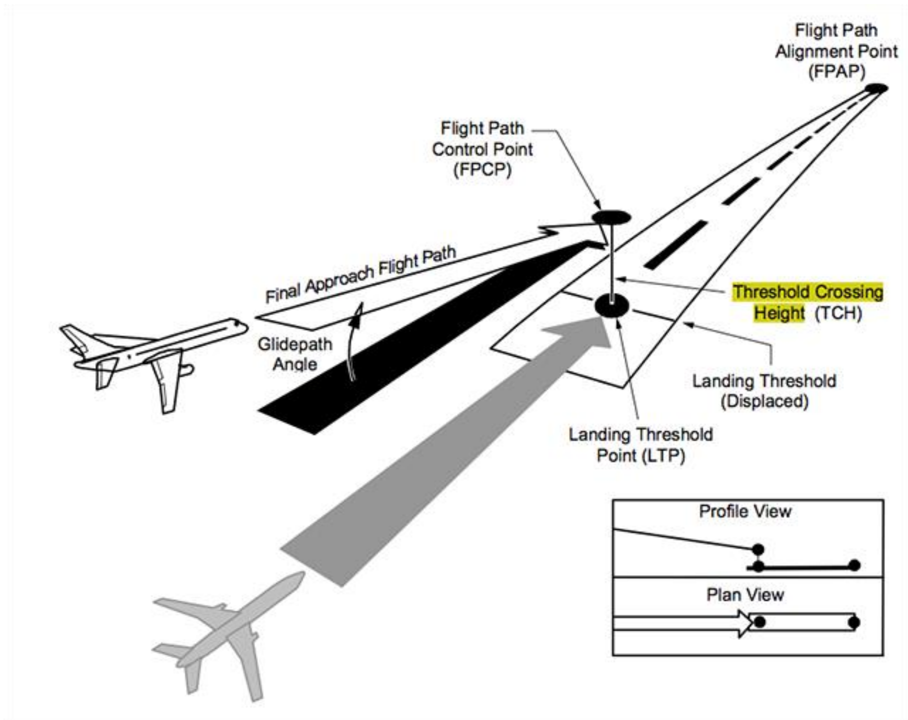


Fig 2.1 Approach path

2.1.1. Description of drag

Studying the topic of flight control during landing, I encountered a very important factor such as drag force

In further stages, we consider in detail this power

It is known from everyday practice that the flow of a real liquid gas acts with some force on a body placed in this flow. For an axisymmetric body with an axis of symmetry directed along the flow, this force will also be directed along the flow. It is called the force of frontal resistance. This force increases with an increase in the flow rate, similar to an increase in the pressure drop with an increase in the fluid flow rate.

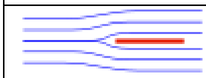
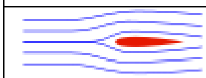
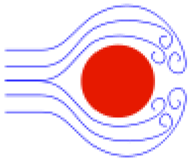
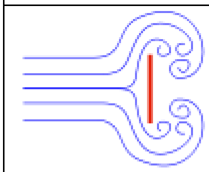
Flow and form obstacles	**Resistance shape**	Influence frictional viscosity
	0%	~100 %
	~10%	~90 %
	~90%	~10 %
	100%	0%

Table 2.1.1 drag-to-figure ratio

2.1.2 Calculation of drag at zero point

This type of drag does not depend on the value of the created lift and is made up of the profile resistance of the wing, the resistance of the aircraft structural elements that do not contribute to the lift, and wave resistance. The latter is significant when moving with near- and supersonic speeds, and is caused by the formation of a shock wave that carries away a significant fraction of the energy of motion. Wave drag occurs when the airplane reaches a speed corresponding to the critical Mach number, when part of the flow around the airplane wing acquires supersonic speed. The critical number M is the greater, the greater the sweep angle of the wing, the more sharpened the leading edge of the wing and the thinner it is.

The resistance force is directed against the speed of movement, its value is proportional to the characteristic area S, the density of the medium ρ and the square of the speed V:

$$\boldsymbol{F = C_X \frac{\rho V^2}{2} \cdot S}$$

where CX is the drag coefficient of a body of a given shape. The area of the quadratic dependence of the force on the velocity v

$$FII = C_X\,(Re) \cdot S \cdot \frac{\rho V^2}{2}$$

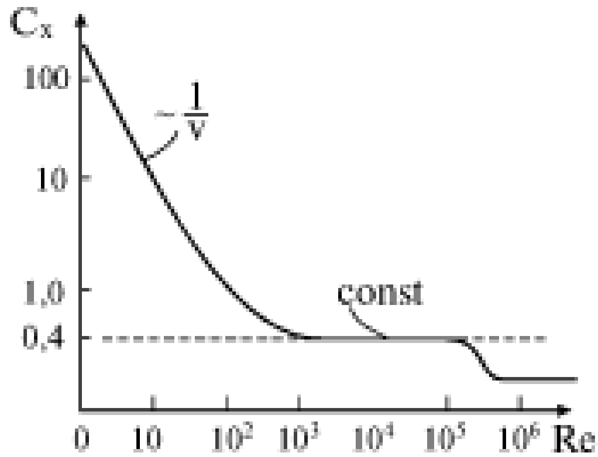
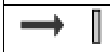
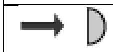
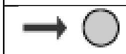
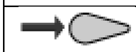


Fig. 2.1.2 Hydraulic coefficient to Re number ratio

As known, for laminar and turbulent flow around bodies, we can use a single formula to calculate the drag force in which the drag coefficient should depend on the speed as shown in Fig (2.1.2). In its appearance, this dependence is very similar to the dependence of the dimensionless hydraulic coefficient on the Re number.A good illustration of the emergence of the drag force due to the asymmetric flow around the body are the values of the drag coefficients of bodies of various shapes presented in the table.

Table 21.2. drag coefficients of bodies of various shapes

	body	**C_x**
	rectangle	1,95
	hemisphere	1,35...1,40
	hemisphere	0,30...0,40
	ball	0,4
	teardrop	0,045
	teardrop	0,1

It is clearly seen that the lowest drag coefficient is possessed by an axisymmetric drop-shaped body, which has a blunt nose and a pointed rear part. When flowing around this body, the flow closes well behind it, thereby preventing the pressure drop behind the body.

2.1.3 Aerodynamic quality

Aerodynamic quality of the aircraft is the ratio of the lift force to the frontal resistance in the associated airplane coordinate system (or the ratio of their coefficients) at given angle of attack.

$$K(\alpha) = \frac{C_y}{C_x}$$

Lifting force - is a useful aerodynamic force that holds the aircraft in the air. Frontal drag, on the contrary, leads to additional energy consumption of the aircraft and is a harmful component. Thus, their ratio allows us to characterize the quality of the airplane. Higher aerodynamic qualities correspond to greater lifting force or less resistance to movement. But no always the drage is harmful force.

The maximum aerodynamic quality value for an aircraft corresponds to the most advantageous angle of attack for gliding at maximum range in a calm atmosphere. Aerodynamic efficiency of the aircraft is determined by the lower drag for a given lift.

In simple terms, aerodynamic quality can be thought of as the distance that an airplane can fly from a certain altitude in calm weather with the engine turned off (if any). For example, on a glider the quality is usually around 30, and on a hang glider it is 10). That is, from a height of 1 kilometer, a sports glider can fly about 30 km under ideal conditions, and a hang glider - 10

In this case, the aerodynamic quality is 17, it mean our airplane can fly 17 km from a height of 1 km without engine assistance.

2.2 Design approach

As it was said earlier, an airplane is a rather fragile structure, and piloting is a rather complicated process, since air is a low-density medium. When approaching, the aircraft must follow the landing glide path with high accuracy in order to get to the beginning of the runway with a certain course and speed, the approach process begins at a great distance from the airfield, landing can be carried out in poor weather conditions; therefore, aircraft control is considered the most important stage landing

To improve the controllability of the aircraft during landing, various mechanisms such as spoilers, flaps and slats are provided.

Air brakes, air brake - a control surface of the aircraft designed to extinguish the flight speed by increasing the resistance. It is also used in the construction of high-speed trains and cars.

The efficiency of aerodynamic brakes (air brakes) depending on the velocity of incoming air stream, so it's impossible to brake using only air brake system. That's mean for fully breaking are require additional breaking component (usually wheel brakes and reverse thrust, if available).

used air brakes to increase the glide path angle during landing in civil and sport aviation. This given possibility to land on poor approaches areas, such as those located in mountainous areas. The military aircraft such as combat aircraft are using airbrake system for limiting the dive speed.

Spoilers are often called air brakes, because they also doing the similar operation, but, actually spoiler is different aggregate. The spoiler is an element for direct control of the lift force of the wing and its used for lateral control or reducing of the lift force.

The present invention relates to a device and method for creating aerodynamic drag on an aircraft using a brake flap

Therefore, the aim of the present invention is to provide a device for creating aerodynamic drag on an aircraft, which does not reduce lift, which causes less noise and which does not apply additional torque to the aircraft, thus effectively reducing the speed of the aircraft during landing approach and also increasing the controllability of the aircraft. when approaching

This objective is achieved by means of at least one brake flap, which is installed on the aircraft fuselage in the area above the aircraft wings.

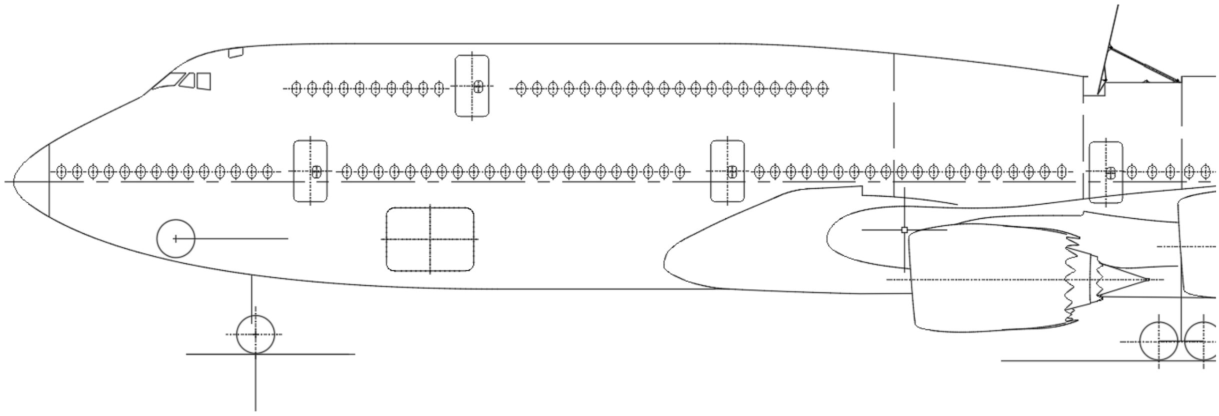


Fig 2.2.1 above the fuselage brake flap

Brake flaps (dorsal aerodynamic brakes) are located in the area on the aircraft fuselage, in which a high dynamic air pressure is generated. In the case of a conventional commercial aircraft, the high dynamic pressure zone suitable for the installation of these devices should be located, for example, above the low pressure side of the wings of the aircraft, near the fuselage, which is the side on which the air flow is accelerated. Placing brake flaps on the fuselage in this area reduces the dynamic pressure of the air flow. The energy used for the indicated purpose is taken from the kinetic energy of the aircraft.

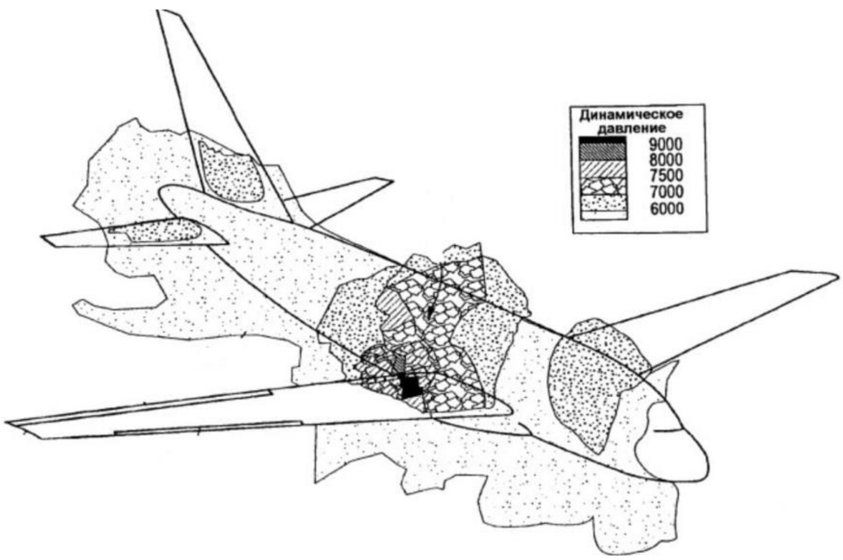


Fig 2.2.2 illustration of the distribution of dynamic pressure at different places of the aircraft.

Changing the pressure distribution, in particular on a wing in a high lift configuration, by means of such a device induces a moment at the pitch angle downward (negative pitching moment factor). In addition, the incident flow relative to the brake flaps produces a torque at an upward pitch angle (positive pitching moment factor). These two factors of pitching moment are balanced by the correct choice of the exact location of the brake flaps on the airplane. In addition, the aerodynamic drag generated by the aircraft can also be increased by the optimal placement of the brake flaps on the aircraft, which, in combination with the aforementioned increase in flow resistance, results in an additional increase in braking action. The braking effect of the dorsal aerodynamic brakes affects the flow around the wings and thus the high lift wing flaps are noticeably less than a conventional spoiler arrangement. Therefore, changing the pressure distribution can not only increase drag, but also reduce the loss of lift.

The noise generated by such brake flaps is also significantly less than prior art, since the wings and fuselage of the aircraft block the propagation of the noise generated by the brake flaps towards the ground. Replacement of wing-mounted spoilers that predominantly affect the flow around the wing of the leading edge flaps (slats) means that the overall aircraft noise can be reduced by means of dorsal air brakes.

2.3. Calculation for special part

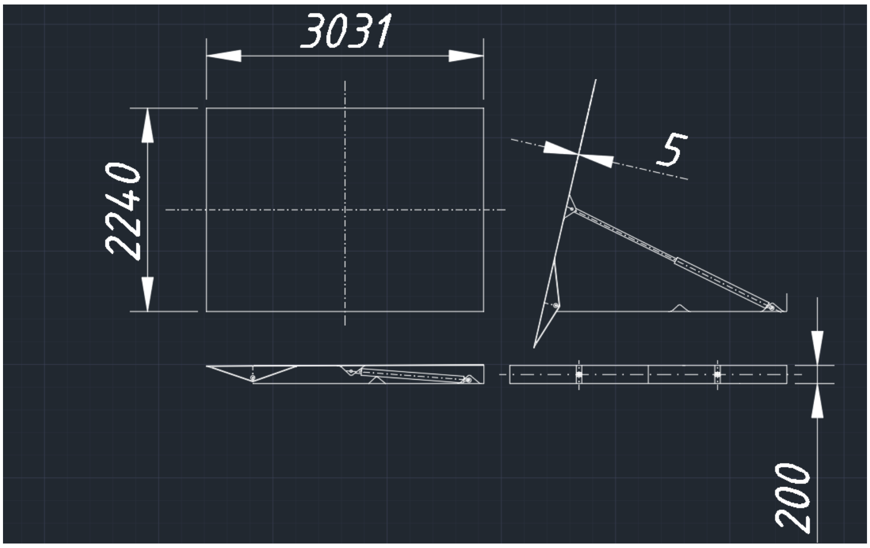


Fig 2.3.1 Mechanism of over the fuselage brakes flap

Calculation of the coefficient of drag, coefficient should depend on the speed as shown in Fig 2.3.2

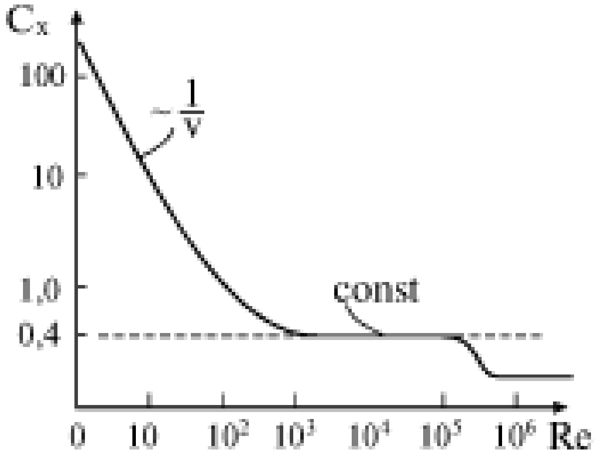


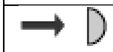
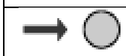
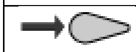
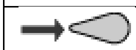
Fig 2.3.2 Hydraulic coefficient to Re number ratio

The resistance force is directed against the speed of movement, its value is proportional to the characteristic area S, the density of the medium ρ and the square of the speed V

$$F = C_X \frac{\rho V^2}{2} \cdot S$$

where C_X is the drag coefficient of a body of a given shape.

Table 2.3.1 drag coefficient of a different body

	body	**C_x**
	rectangle	1,95
	hemisphere	1,35...1,40
	hemisphere	0,30...0,40
	ball	0,4
	teardrop	0,045
	teardrop	0,1

As it shown in the table (2.3.1), we can observe that our flap has a drag coefficient of 1.95

Accordingly:

$$F = C_X \frac{\rho V^2}{2} \cdot S = 1{,}95 \cdot \frac{1{,}2041 \cdot 67600}{2} \cdot 6.78 = 5380 \text{ kg or } 53800\text{N}$$

Where:

C_X - coefficient of drag of a body of a given shape = 1.95

ρ -density of the medium (at an average temperature on the surface of the earth at standing times of 20 degrees) = 1.2041

V- aircraft speed during landing approach = 260 km / h

S - brake flap area = 6.78 m^2

calculation of the drag of the entire aircraft:

The drag of the entire aircraft will be the sum of the drag of individual parts in the air flow:

$$X = X_{w+} X_{F+} X_{vt+} X_{ht\dots}$$

Where:

X_w= drag wing

X_f - fuselage drag

X_{vt} - drag vertical tail

X_{ht} - horizontal tail drag

In this case aircraft has the total drag of the entire aircraft: 0.03199

2.4 The principal of work

The air braking system can be attributed to an additional system to the main one, since its operation depends only on external and internal factors, such as poor weather conditions at the airfield, a short landing strip, due to which accidents most often occur during landing

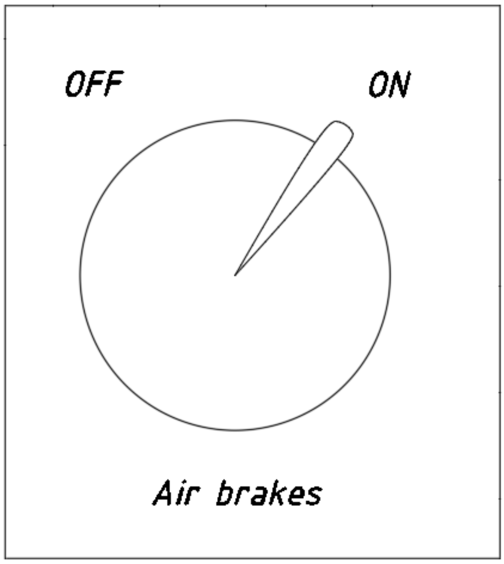


Fig 2.4.1 air brake switch

Therefore, its operation can be limited to turning the modes on and off using the button that is installed on the Spoiler control toggle panel, so as not to burden the pilots additionally when the system is turned on, the air brakes that are installed above the fuselage will automatically operate, for opration system we need such a data on the altitude and flight speed that taken from the on-board computer

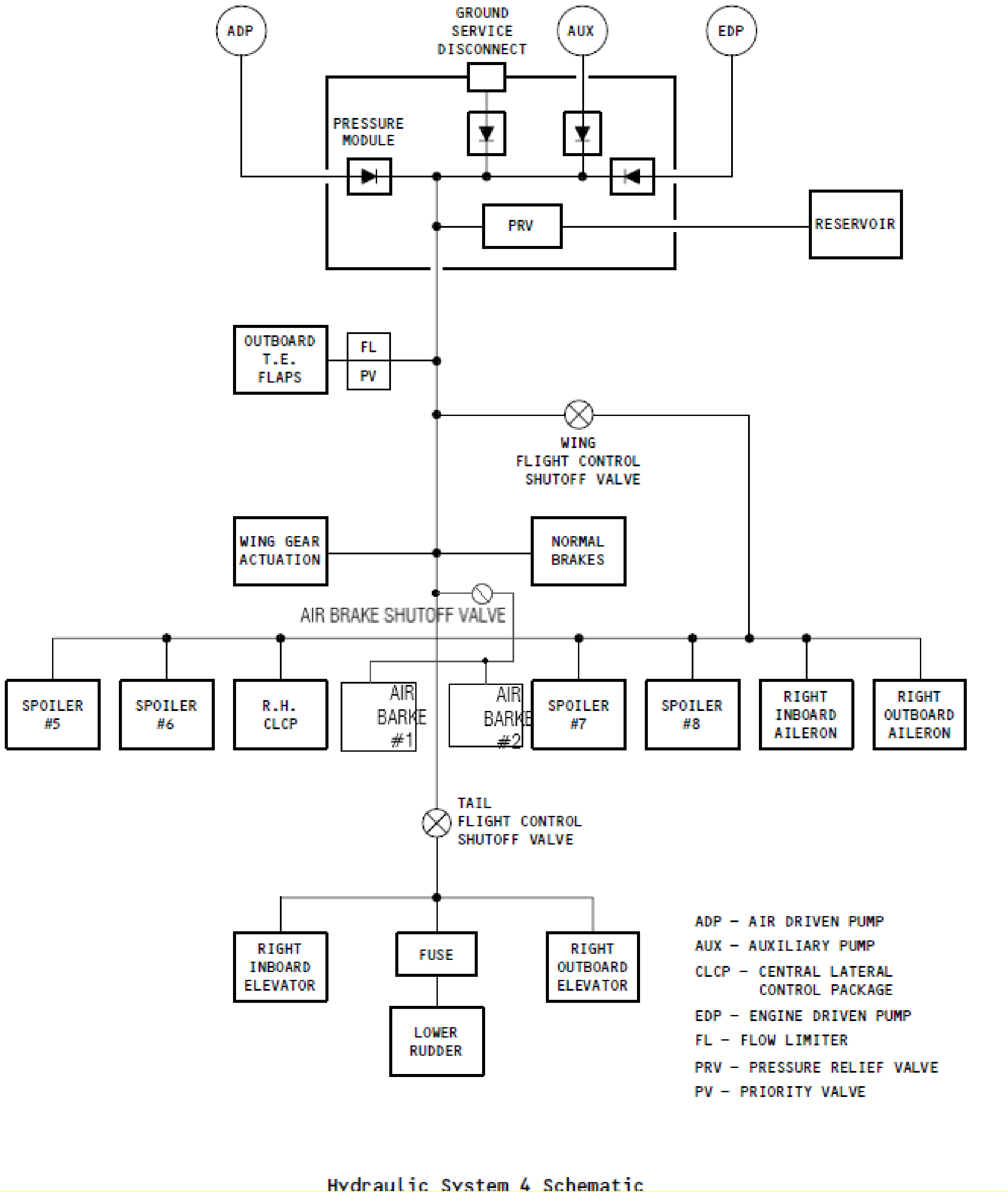


Fig 2.4.2 hydraulic system

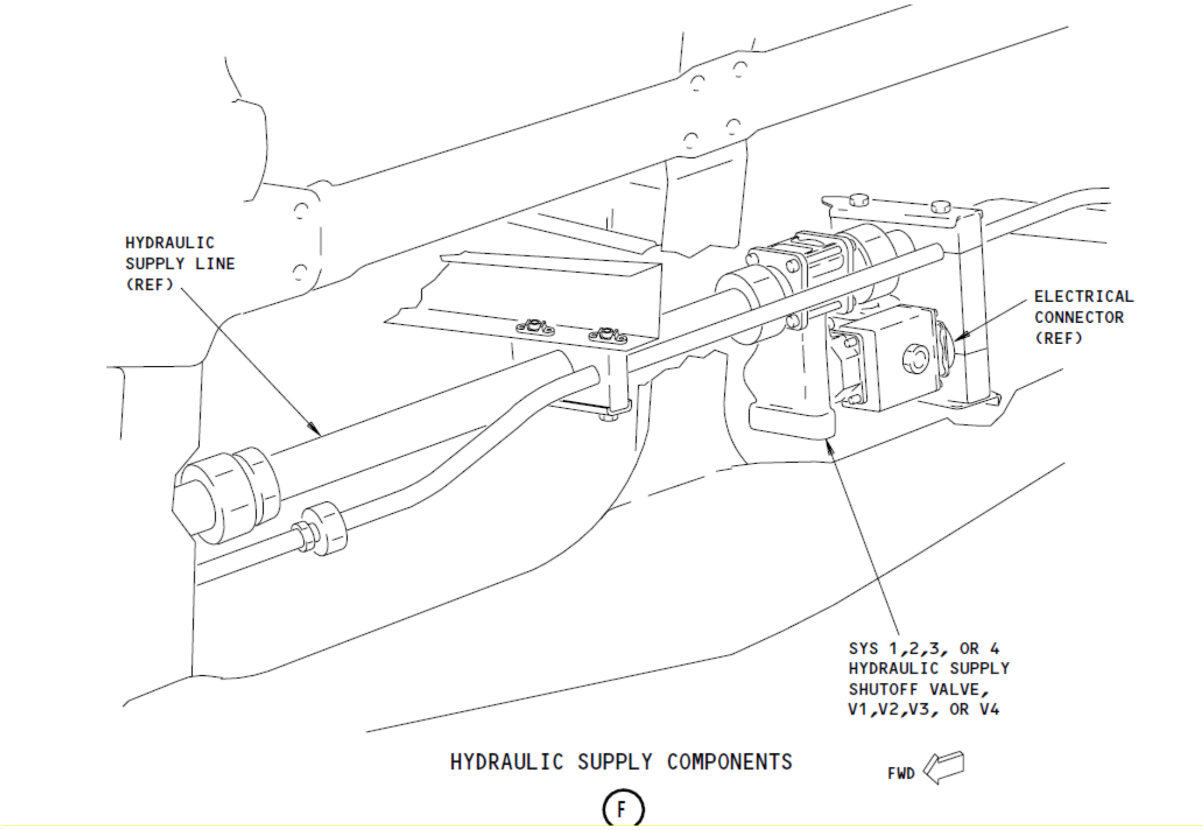


Fig 2.4.3 hydraulic supply components

Accordingly, after the computer sends signals for electrical reception and after the valve opens and the hydraulic fluid enters the cylinder that controls the brake flaps

Thus, the system works autonomously and does not need additional pilot supervision, which makes the landing process even safer.

Conclusions for special part

The next result were gotten during design special part:

- The concept and main principles of air breaking system development were reviewed;

- Was learnt the subject such as drag, aerodynamic coefficient, the problems wich will forced during landing, dynamic pressure at different places of the aircraft and ...

- Analytics of new air breaks flap, its parameters and arrangment were considered;

- Modified hydraulic system was calculated drag force of each flap

- Designed the mechanism of extending and retracting of each flap

- Automatized a additional system with all switches on cockpit

General conclusions

In the course of work I receive the following results:

- conceptual design of long-rang airplane for 364 passengers;
- the cabin layout of the long range aircraft with 364 passengers capacity;
- determination of the center of gravity of the airplane;
- determination of the basic geometric parameters of the LG;
- selection of wheels that meet the requirements;
- the nose and main landing gear calculation and design.
- The concept and main principles of air breaking system development were reviewed;
- Was learnt the subject such as drag, aerodynamic coefficient, the problems wich will forced during landing, dynamic pressure at different places of the aircraft and ...
- Analytics of new air breaks flap, its parameters and arrangment were considered;
- Modified hydraulic system was calculated darge force of each flap

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