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МІНІСТЕРСТВО ОСВІТИ ТА НАУКИ УКРАЇНИ
ДЕРЖАВНЕ НЕКОМЕРЦІЙНЕ ПІДПРИЄМСТВО
«ДЕРЖАВНИЙ УНІВЕРСИТЕТ «КИЇВСЬКИЙ АВІАЦІЙНИЙ ІНСТИТУТ»
КАФЕДРА КОНСТРУКЦІЇ ЛІТАЛЬНИХ АПАРАТІВ

ДОПУСТИТИ ДО ЗАХИСТУ
Завідувач кафедри, к.т.н., доцент
___________ Тетяна МАСЛАК
«____» ____________ 2025 р.

КВАЛІФІКАЦІЙНА РОБОТА

ЗДОБУВАЧА ОСВІТНЬОГО СТУПЕНЯ «БАКАЛАВР»

ЗІ СПЕЦІАЛЬНОСТІ

«АВІАЦІЙНА ТА РАКЕТНО-КОСМІЧНА ТЕХНІКА»

Тема: «Додатковий багажний простір в пасажирському салоні літака ATR-42»

Виконав: __________ **Владислав ПЕТРОВ**

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Нормоконтролер: к.т.н, доц. __________ **Володимир КРАСНОПОЛЬСЬКИЙ**

Київ 2025

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MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
STATE NON-COMMERCIAL COMPANY
"STATE UNIVERSITY "KYIV AVIATION INSTITUTE"
DEPARTMENT OF AIRCRAFT DESIGN

PERMISSION TO DEFEND
Head of the department,
PhD, associate professor
_________ Tetiana MASLAK
"___" ________________ 2025

QUALIFICATION PAPER

FOR A BACHELOR'S DEGREE

ON SPECIALITY

"AVIATION AND AEROSPACE TECHNOLOGIES"

Topic: "Additional luggage space in the passenger cabin of an ATR-42 aircraft"

Submitted by: ____________**Vladyslav PETROV**

Supervisor:
PhD, associate professor ____________**Oleksandr YAKOBCHUK**

Standards inspector
PhD, associate professor ____________**Volodymyr KRASNOPOLSKYI**

Kyiv 2025

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ДЕРЖАВНЕ НЕКОМЕРЦІЙНЕ ПІДПРИЄМСТВО
«ДЕРЖАВНИЙ УНІВЕРСИТЕТ «КИЇВСЬКИЙ АВІАЦІЙНИЙ ІНСТИТУТ»

Аерокосмічний факультет
Кафедра конструкції літальних апаратів
Освітній ступінь «Бакалавр»
Спеціальність «Авіаційна та ракетно-космічна техніка»
Освітньо-професійна програма «Обладнання повітряних суден»

ЗАТВЕРДЖУЮ
Завідувач кафедри, к.т.н., доцент
___________ Тетяна МАСЛАК
«____» ____________ 2025 р.

ЗАВДАННЯ

на виконання кваліфікаційної роботи здобувача вищої освіти

ПЕТРОВА ВЛАДИСЛАВА ВІТАЛІЙОВИЧА

1. Тема роботи: «Додатковий багажний простір у пасажирському салоні літака ATR-42», затверджена наказом ректора від 17 березня 2025 року № 408/ст.
2. Термін виконання роботи: з 26 травня 2025 р. по 22 червня 2025 р.
3. Вихідні дані до роботи: максимальне корисне навантаження 5148 кг, дальність польоту з максимальним завантаженням 1300 км, максимальна злітна маса 22061 кг, швидкість польоту 520 км/год.
4. Зміст пояснювальної записки: вступ, основна частина, що включає аналіз літаків-прототипів і короткий опис проєктованого літака, обґрунтування вихідних даних для розрахунку, розрахунок основних льотно-технічних та геометричних параметрів літака, компонування пасажирської кабіни, розрахунок центрування літака, спеціальна частина, яка містить перегляд компонування літака та варіант перерозподілу декількох рядів для людей із зростом вище середнього, створення додаткового багажного простору під кожним пасажирським сидінням.
5. Перелік обов’язкового графічного (ілюстративного) матеріалу: загальний вигляд літака (А1×1), компонувальне креслення фюзеляжу (А1×1), креслення літака у його перерізі.

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6. Календарний план-графік:

№	Завдання	Термін виконання	Відмітка про виконання
1	Вибір вихідних даних, аналіз льотно-технічних характеристик літаків-прототипів	26.05.2025	
2	Вибір та розрахунок параметрів проєктованого літака	27.05.2025 – 28.05.2025	
3	Виконання компонування літака та розрахунок його центрування	29.05.2025	
4	Розробка креслень по основній частині кваліфікаційної роботи	30.05.2025 – 31.05.2025	
5	Огляд літератури за проблематикою роботи. Аналіз варіантів розробки додаткового простору	01.06.2025	
6	Перегляд компонувальної частини літака. Написання спеціальної частини	02.06.2025 – 03.06.2025	
7	Оформлення пояснювальної записки та графічної частини	04.06.2025	
8	Попередній захист кваліфікаційної роботи	05.06.2025 – 06.06.2025	
9	Подача роботи для перевірки на плагіат	07.06.2025 – 11.06.2025	
10	Виправлення зауважень. Підготовка супровідних документів та презентації доповіді	12.06.2025 – 17.06.2025	
11	Захист кваліфікаційної роботи	18.06.2025 – 22.06.2025	

7. Дата видачі завдання: 26 травня 2025 року

Керівник кваліфікаційної роботи ____________ Олександр ЯКОБЧУК

Завдання прийняв до виконання ____________ Владислав ПЕТРОВ

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STATE NON-COMMERCIAL COMPANY
"STATE UNIVERSITY "KYIV AVIATION INSTITUTE"

Aerospace Faculty
Department of Aircraft Design
Educational Degree "Bachelor"
Specialty "Aviation and Aerospace Technologies"
Educational Professional Program "Aircraft Equipment"

APPROVED BY
Head of the department,
PhD, associate professor
_________ Tetiana MASLAK
"___" _______________ 2025

TASK

for the bachelor degree thesis

Vladyslav PETROV

1. Topic: "Additional luggage space in the passenger cabin of the ATR-42 aircraft", approved by the Rector's order № 408/ст from 17 March 2025.
2. Period of work: since 26 May 2025 till 22 June 2025.
3. Initial data: maximum payload 5148 kg, flight range with maximum load 1300 km, maximum take-off weight 22061 kg, flight speed 520 km/h.
4. Content (list of topics to be developed): introduction, main part: analysis of prototypes and brief description of designing aircraft, selection of initial data, wing geometry calculation and aircraft layout, landing gear design, engine selection, center of gravity calculation, special part: revision of the aircraft layout and the option of redistributing several rows for people with above-average height, creating additional luggage space under each passenger seat.
5. Required material: general view of the airplane (A1×1), layout of the airplane (A1×1), a cross-sectional drawing of an aircraft.

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6. Thesis schedule:

№	Task	Time limits	Done
1	Selection of initial data, analysis of flight technical characteristics of prototypes aircrafts	26.05.2025	
2	Selection and calculation of the aircraft designed parameters	27.05.2025 – 28.05.2025	
3	Performing of aircraft layout and centering calculation	29.05.2025	
4	Development of drawings on the thesis main part	30.05.2025 – 31.05.2025	
5	Analysis of options for developing additional space	01.06.2025	
6	Viewing the aircraft's components. Special part preparation	02.06.2025 – 03.06.2025	
7	Explanatory note checking, editing, preparation of the qualification paper graphic part	04.06.2025	
8	Preliminary defense of the thesis	05.06.2025 – 06.06.2025	
9	Submission of the work to plagiarism check	07.06.2025 – 11.06.2025	
10	Making corrections, preparation of documentation and presentation	12.06.2025 – 17.06.2025	
11	Defense of the qualification paper	18.06.2025 – 22.06.2025	

7. Date of the task issue: 26 May 2025

Supervisor: ____________ Oleksandr YAKOBCHUK

Student: ____________ Vladyslav PETROV

РЕФЕРАТ

Пояснювальна записка кваліфікаційної роботи «Додатковий багажний простір в пасажирському салоні літака ATR-42»:

60 с., 20 рис., 13 табл., 10 джерел

Дана кваліфікаційна робота присвячена розробці аванпроєкту пасажирського літака для ближньомагістральних авіаліній з можливістю перегляду кроку сидінь перших чотирьох рядів, створення додаткового багажного простору під пасажирськими сидіннями.

В роботі було використано методи аналітичного розрахунку, комп'ютерного проєктування за допомогою CAD/CAM/CAE систем, ескізного проєктування механізму завантаження з використанням технічних даних подібних пристроїв.

Практичне значення результату кваліфікаційної роботи полягає в підвищенні якості та комфорті перевезення пасажирів шляхом перерозподілу перших чотирьох рядів та створенні додаткового багажного простору.

Матеріали кваліфікаційної роботи можуть бути використані в навчальному процесі та в практичній діяльності конструкторів спеціалізованих проєктних установ.

Пасажирський літак, компонування, центрування, порівняльні дані, перцентилій, крок сидінь, багажний простір

ABSTRACT

Bachelor degree thesis "Additional luggage space in the passenger cabin of an ATR-42 aircraft"

60 pages, 20 figures, 13 tables, 10 references

This thesis is dedicated to preliminary design of short-haul airlines with the ability to adjust the seat pitch of the first four rows, creating additional luggage space under the passenger seats.

The design methodology is based on prototype analysis to select the most advanced technical decisions, engineering calculations to get the technical data of designed aircraft and computer-based design using CAD/CAM/CAE systems. In special part percentile data and layout drawings were used to analyze possible modifications to passenger seats

Practical value of the work is Improving the quality and comfort of passenger transportation by redistributing the first four rows and creating additional luggage space.

The materials of the bachelor's thesis can be used in the aviation industry and in the educational process of aviation specialties.

Passenger aircraft, cabin layout, center of gravity calculation, comparative data, percentiles, seat pitch, luggage space

Format	№	Designation	Name	Quantity	Notes
			General documents		
A4	1	KAI 25 08P 00 00 00 28 TW	Task for work	1	
	2	KAI 25 08P 00 00 00 28	Short-range passenger aircraft	2	
A1		KAI 25 08P 00 00 00 28 GV	General view	1	
A1		KAI 25 08P 00 00 00 28 FL	Fuselage layout	1	
A4	3	KAI 25 08P 00 00 00 28 EN	Short-range passenger aircraft	60	
			explanatory note		
			Documentation for assembly units		
A1	4	KAI 25 08P 00 00 00 28 AD	Design of passenger seats	1	

Sh.	№ doc.	Sign	Date	KAI 25 08P 00 00 00 28 EN			
Done by	Petrov V.V			Preliminary design of short-range passenger aircraft (List of diploma work)	list	sheet	sheets
Supervisor	Yakobchuk O.Y.				Q	9	60
St.control.	Krasnopolskyi V.S.				Ba-134-21-1-OC		
Head of dep.	Maslak T.P.						

CONTENT

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INTRODUCTION

Regional passenger transport is no less important or influential than long-distance transport. It significantly saves time for people who need to get from one place to another within the country. The situation is the same with freight transport.

The choice of the topic for this course project, "Exploring Innovative Design for Next-Generation ATR 42 Aircraft," stems from the significant potential for advancements in regional aircraft technology and the growing demand for more efficient and environmentally friendly air transportation solutions. The ATR 42, renowned for its reliability and versatility in regional operations within a country or in some foreign neighbor cities, for instance Warsaw etc. presents an excellent platform for pushing the boundaries of design innovation to meet evolving industry needs.

	List	# document	Signat.	Date	KAI 25 08P 00 00 00 28 EN
Done by		Petrov V.V			INTRODUCTION
Checked by		Yakobchuk O.Y			Let. / Page 12 / Pages 60
St.control		Krasnopolsky V.S			Ba-134-21-1-OC
Head of dep.		Maslak T.P			

1. ANALYSIS OF PROTOTYPES AND SHORT DESCRIPTION OF DESIGNING AIRCRAFT

1.1. Statistic data of prototypes

ATR 42: The ATR 42 prototype focuses on enhancing fuel efficiency and passenger comfort through the integration of advanced materials, sustainable propulsion systems, and modern avionics. It features a redesigned cabin layout for improved passenger experience and flexibility.

AN 140: The AN 140 prototype emphasizes ruggedness and versatility, catering to harsh operating environments and specialized missions such as cargo transport and humanitarian aid. It incorporates robust construction, simplified systems, and adaptable configurations for diverse operational requirements.

Airbus A220: The Airbus A220 prototype prioritizes performance and innovation, leveraging advanced aerodynamics, efficient propulsion systems, and cutting-edge avionics. It offers superior fuel efficiency, range, and passenger comfort, making it ideal for both short-haul regional routes and longer-distance operations.

The ATR 42 features sleek lines and a modern, streamlined fuselage, with efficient turboprop engines mounted on high wings for improved performance and accessibility to short runways.

The AN 140 exhibits a rugged exterior design with a sturdy airframe and high wings, showcasing its capability to operate in challenging environments. Its twin-engine configuration ensures reliability and redundancy for critical missions.

The Airbus A220 boasts a distinctive appearance with its blended wing-body design, optimized for aerodynamic efficiency and fuel savings. Its high-mounted engines and spacious cabin provide a comfortable and enjoyable flying experience for passengers.

The main prototypes are ATR42, AN140, Airbus A220, their performances are presented in the tables 1.1-1.5.

Table 1.1.

Statistic data of prototypes. Main parameters

Name and dimensionality	ATR 42	AN 140	Airbus A220
Max payload, kg	5148	6000	23950
Crew, number of pilot	2	2	2
Passengers (max)	52	52	160
Wing loading, kN/m^2 *Wing area/MTOW*	450 3.2	352 4.45	530 4.52
lift-to-drag ratio	13.22	16	20
Flight range with max paylod, km	1300	1900	3350
Cruise Altitude, km	6	8.5	12.5
For turbojets Thrust/weight ratio, N/kg *Thrust of all engines/MTOW*	–	–	3.06
For turboprops Power/weight ratio, kW/kg *Power of all engines/MTOW*	0.25	0.16	–
Fuel consumption, gt/km	0.27	0.25	2,2

Table 1.2

Power plant data

Name and dimensionality	ATR 42	AN 140	Airbus A220
Number of engines and their type	2 turboprops	2 turboprops KlimovTV3-117VMA-SBM1	2 turbojets Pratt & Whitney PW1500G
Take off thrust, kN	2324	2000	13000
Take off power, kN	2000	1600	90 MW
Cruising thrust, kN	2000	1652	11000
Spec. fuel cons., take off, kg/kN	0.2702	0.218	0.65
Spec. fuel cons., cruising, kg/kN	0.2332	0.179	0.55
Pressure ratio	Not specified	Not specified	Approximately 40 to 45
Bypass ratio	Not specified	Not specified	Approximately 12 to 15

Take off and landing characteristics

Table 1.3

Name and dimensionality	ATR 42	AN 140	Airbus A220
Aerodrome code letter	C	C	C or D
Approach speed, km/h	217.31	185	240
Landing speed, km/h	202.01	160	220
Speed of take off, km/h	211.63	200	240
Take off run distance, m	640	1000	1800
Landing run distance, m	575	900	1100
Take off distance, m	578	1300	2100
Landing distance, m	1088	1200	1300

Airplane mass data

Table 1.4

Name and dimensionality	ATR 42	AN 140	Airbus A220
MTOW Maximum Take Off Mass, kg	22061	21500	68000
Landing mass, kg	20676	21000	60000
Empty weight kg	11700	12500	35000
Fuel fraction, % *Total fuel/MTOW*	43 %	43 %	43 %
Payload fraction, % *Maximum payload/MTOW*	17 %	17 %	45 %

Table 1.5

Main geometrical parameters

Name and dimensionality	ATR 42	AN 140	Airbus A220
1	2	3	4
Wing span, m	25	24.5	35.10
Sweepback angle at ¼ of the chord, °	25	25	25
Mean geometric chord, m	2.51	3.46	3.35
Wing aspect ratio	9.5	9.8	10.46
Wing taper ratio	0.31	0.3	0.24
Fuselage length, m	22.67	22.63	35.61
Fuselage diameter, m	2.8	2.8	3.6
Fuselage fineness ratio (L_f/D_f)	7.5	8.082	9.89
Passenger cabin width, m	2.5	2.5	3.28

Ending of table 1.5

1	2	3	4
Passenger cabin length, m	16	15.68	27.28
Cabin height, m	1.9	2.1	2.2
Seat pitch, m	0.78	0.76	0.79
Aisle width, m	0.53	0.48	0.5
Horizontal tail span, m	9	9.05	13.30
Horizontal tail sweepback angle, °	25	25	33
Horizontal tail aspect ratio	5.5	6.26	5.06
Horizontal tail taper ratio	0.4	0.5	0.25
Vertical tail height, m	7.5	4.3	7.6
Vertical tail sweepback angle, °	35	35	35
Vertical tail aspect ratio	1.7	1.75	2.17
Vertical tail taper ratio	0.45	Not specified	Not specified
Landing gear wheel base, m	8	8.05	9.81
Landing gear wheel track, m	3.5	5.5	5.98

1.2. Classification of your designing aircraft according to the flight performances and layout

The classification of the designed aircraft according to flight technical characteristics and layout is indicated in the table 1.6.

Table 1.6

Aircraft classification according to the flight technical characteristics and layout	ATR 42
1	2
. Purpose of the aircraft	Passenger commercial
2. Speed of flight (Much number)	520 km/h subsonic (M=0.45)
3.Range of flight	Flight range 1300 km, low-range aircraft
4.Flight duration	2.5hours short-haul flight
5.ICAO category	Commuter
6. FAA Airplane Design Group	The ADG classification is based on criteria such as wingspan, tail height, and maximum certificated takeoff weight. ADG III includes aircraft with wingspans greater than 49 feet but less than 79 feet, tail heights greater than 20 feet but less than 30 feet, and maximum certificated takeoff weights greater than 12,500 pounds but less than 45,000 pounds.

1	2
7. ICAO / EASA Aerodrome Reference Code	ICAO Aerodrome Reference Code: The ICAO ARC system is based on the aircraft's wingspan. The ATR 42 has a wingspan that typically falls within the ICAO Aerodrome Reference Code of Code C. EASA Aerodrome Reference Code: The EASA (European Union Aviation Safety Agency) also has its own ARC system, which takes into account both wingspan and outer main gear spread. The ATR 72, depending on its specific configuration and dimensions, may fall under EASA's Aerodrome Reference Code as Code C or Code D.
8. Aircraft Approach Category	217.31 km/h
9. Maximum take-off mass	Medium MTOW= 20676 kg
Describe the aerodynamic scheme of the aircraft	
Monoplane or biplane	Monoplane
High/mid/low wing position	High wing position
Swept or straight wing	Straight wing
Cantilever or braced	Cantilever
With or without winglets	Without winglets
Type of the fuselage cross-section	
Wide-body or narrow-body	Narrow-body
T-type or conventional type of the tail unit	Conventional type
What type of stabilizer: fixed or adjustable	Fixed
Type of landing gear scheme: tricycle with nose wheel or multi bogy	Tricycle configuration with a nose wheel
Quantity of engines	2
Type of engines	Turboprop
Where the engines are located?	Located on the wings, specifically mounted on pylons positioned underneath the wings' surface

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Conclusions to the analytical part

After studying and comparing the technical specifications and flight characteristics of multiple regional aircraft the ATR 42 was selected as the optimal prototype due to its compact configuration, efficient, fuel consumption and well established use on short range routes in various countries. This aircraft serves as the basis for the development of the designed model with a maximum capacity of 52 passengers which corresponds to the typical capacity of short haul turboprop airliners.

The decision to choose the ATR 42 was driven by several factors primarily its aerodynamic, layout, high operational flexibility and compatibility with regional airports with limited infrastructure. In addition the geometry of the ATR 42 provides a balanced distribution between fuselage volume, cabin dimensions and aerodynamic efficiency, making it a suitable reference for further structural and ergonomic improvements.

The designed aircraft falls within the category of short-range civil aviation transport with a standard low wing configuration, single vertical tail unit and a classic tricycle landing gear layout. According to its flight performance parameters it can be classified as a regional commuter aircraft capable of operating on routes up to 1500 kilometers at cruise speeds of approximately 550 kilometers per hour.

2. AIRCRAFT GEOMETRY CALCULATION

In the context of aircraft preliminary design the main geometrical parameters of all parts of the designing aircraft need consideration.

The wing design and high lift devices calculations, the fuselage geometry and cabin layout, landing gear design, tail unit design will be calculated in this paragraph. The engines will be chosen from the list of engines which are used nowadays in operation.

2.1. Wing geometry calculation

For the designing aircraft, the initial data have been calculated by special computer program designed at the Aircraft Design Department of KAI. The data are presented in Appendix A. (Initial data of aircraft).

During the preliminary design stage, the usual practice is to choose the airfoil from the large number of airfoils whose geometric and aerodynamic characteristics are available in the aeronautical literature.

1. Wing airfoil: For designing aircraft Laminar type by NASA was taken.
2. Relative thickness of the airfoil is 0.12 (from initial data).
3. Location of the wing on fuselage: High-wing.
4. Aspect ratio of the wing λ_w 9.5.
5. Taper ratio of the wing η_w 2.1 The taper ratio influences the following quantities: induced drag, structural weight, ease of fabrication.
6. Sweep back angle of a wing is 0.
7. Wing area (S_{wing}): This is calculated from the wing loading and gross weight which have been already decided, (in appendix A).

$$S_{wing} = \frac{m_0 \cdot g}{P_0} = \frac{22061 \cdot 9.8}{3152} = 68 \text{ m}^2,$$

where m_o – take off mass of the aircraft;

g – gravitational acceleration,

P_o – wing loading at cruise regime of flight.

After the calculation, we compare the area of our wing with a wing area of prototypes and if it necessary we could recalculate it.

So, we take the wing area $S_{wing} = 68\ m^2$.

8.Wing span is:

$$l = \sqrt{S_{wing} \cdot \lambda_w} = \sqrt{68 \cdot 9.5} = 25 \text{ m.}$$

9. Root chord is:

$$C_{root} = \frac{2 \cdot 68 \cdot 2.1}{(1 + 2.1) \cdot 25} = 3.7 \text{ m.}$$

10. Tip chord is:

$$C_{tip} = \frac{3.7}{2.1} = 1.76 \text{ m.}$$

11. On board chord for trapezoidal shaped wing is:

$$C_{board} = C_{root} \cdot \left(1 - \frac{(\eta_w - 1) \cdot D_f}{\eta_w \cdot l_w}\right) = 4 \cdot \left(\frac{(3.98 - 1) \cdot 5.64}{3.98 \cdot 48}\right) = 3.28 \text{ m.}$$

12. Wing construction and spars position.

To choose the structure scheme of the wing it is necessary to determine the type of its internal design. The torsion box type with two spars was chosen to meet the requirements of strength and at the same time to make the structure comparatively light.

Relative coordination of the spar's position is equal:

for a wing with two spars: $x_{1spar} = 0.2\ C_i$; $x_{2spar} = 0.6\ C_i$ from the leading edge of current chord in the wing cross-section,

The spars are shown at the drawing (appendix B).

13. Mean aerodynamic chord definition.

The geometrical method of mean aerodynamic chord determination has been taken, which is presented at Appendix B and at the fig. 2.1.

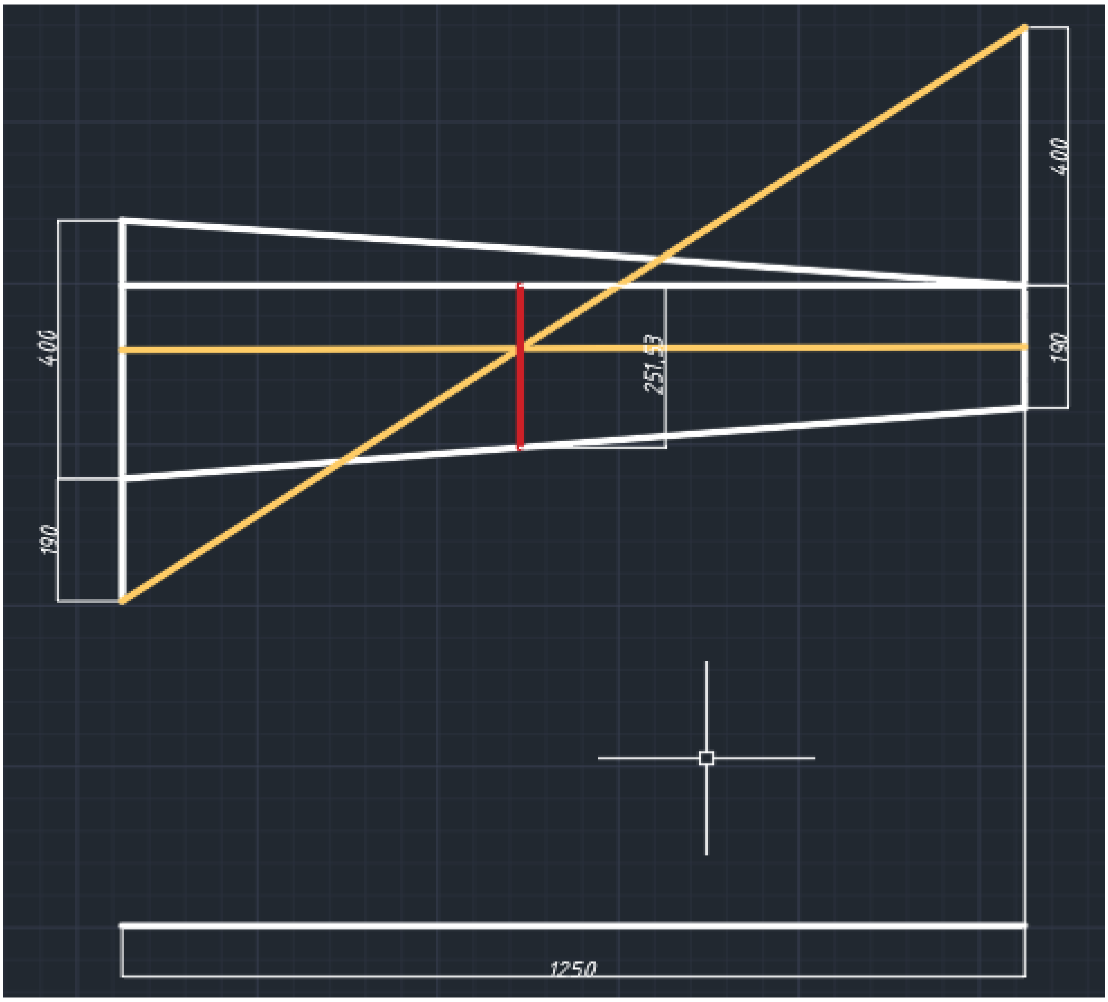

Fig. 2.1. Determination of mean aerodynamic chord

Mean aerodynamic chord is equal $b_{MAC} = 2.51$ m.

Also we could calculate the MAC by the approximately formulas:

For trapezoidal wing shape:

$$b_{MAC} = \frac{2}{3}\frac{C^2_{root} + C_{root}C_{tip} + C^2_{tip}}{C_{root} + C_{tip}} = 2.51 \text{ m.}$$

After determination of the geometrical characteristics of the wing we could come to the estimation of the aileron's geometry and high-lift devices.

14. Ailerons design.

The main purpose of the ailerons is to create rolling moment and provide adequate rate of roll. Ailerons geometrical parameters are determined by the next formulas:

Ailerons span:

$$l_{aileron} = (0.3..0.4) l_{wing} / 2$$

Ailerons chord:

$$C_{aileron} = (0.22..0.26) C_i$$

Aileron area:

$$S_{aileron} = (0.05..0.08) S_{wing} / 2$$

Ailerons are equipped by the secondary control surfaces (aerodynamic balance).

Inner axial balance:

$$S_{in\ axial} = (0.3..0.31) S_{aileron};$$

Area of aileron's trim tabs for the aircraft with two engines:

$$S_{trim\ tabs} = (0.04..0.06) S_{aileron};$$

For the aircraft with four engines:

$$S_{trim\ tabs} = (0.07..0.08) S_{aileron};$$

Range of aileron deflection: upward:

$$\delta_{aileron} \ge 25° \ downward\ \delta_{aileron} \ge 15°$$

So, the results are:

Ailerons span:

$$l_{aileron} = 0.35 \frac{l_w}{2} = 0.35 \cdot \frac{25}{2} = 4.38 \text{ m.}$$

Ailerons chord:

$$C_{aileron} = (0.22..0.26) C_i = 0.25 \cdot 1.71 = 0.427 \text{ m.}$$

Aileron area:

$$S_{aileron} = 0.06 \frac{S_w}{2} = 0.06 \cdot \frac{68}{2} = 2.04 \text{ m.}$$

For the aircraft with two engines:

$$S_{trim\ tabs} = (0.04..0.06) S_{aileron};$$

$$S_{trim\ tabs} = 0.06 \cdot S_{aileron} = 0.06 \cdot 2.04 \approx 0.12 \text{ m}^2$$

13. High lift device of a wing: Double slotted flaps together with slats.

High-lift Device Coefficient 0.58,

where 0.58 – single slotted flap, or other simple high-lift device;

`

The relative coordination of high-lift devices on the wing chord are:

$C_f = (0.28..0.3)C_i$ – for one slotted and two slotted flaps;

$$C_f = 0.29 \cdot 2.51 = 0.73$$

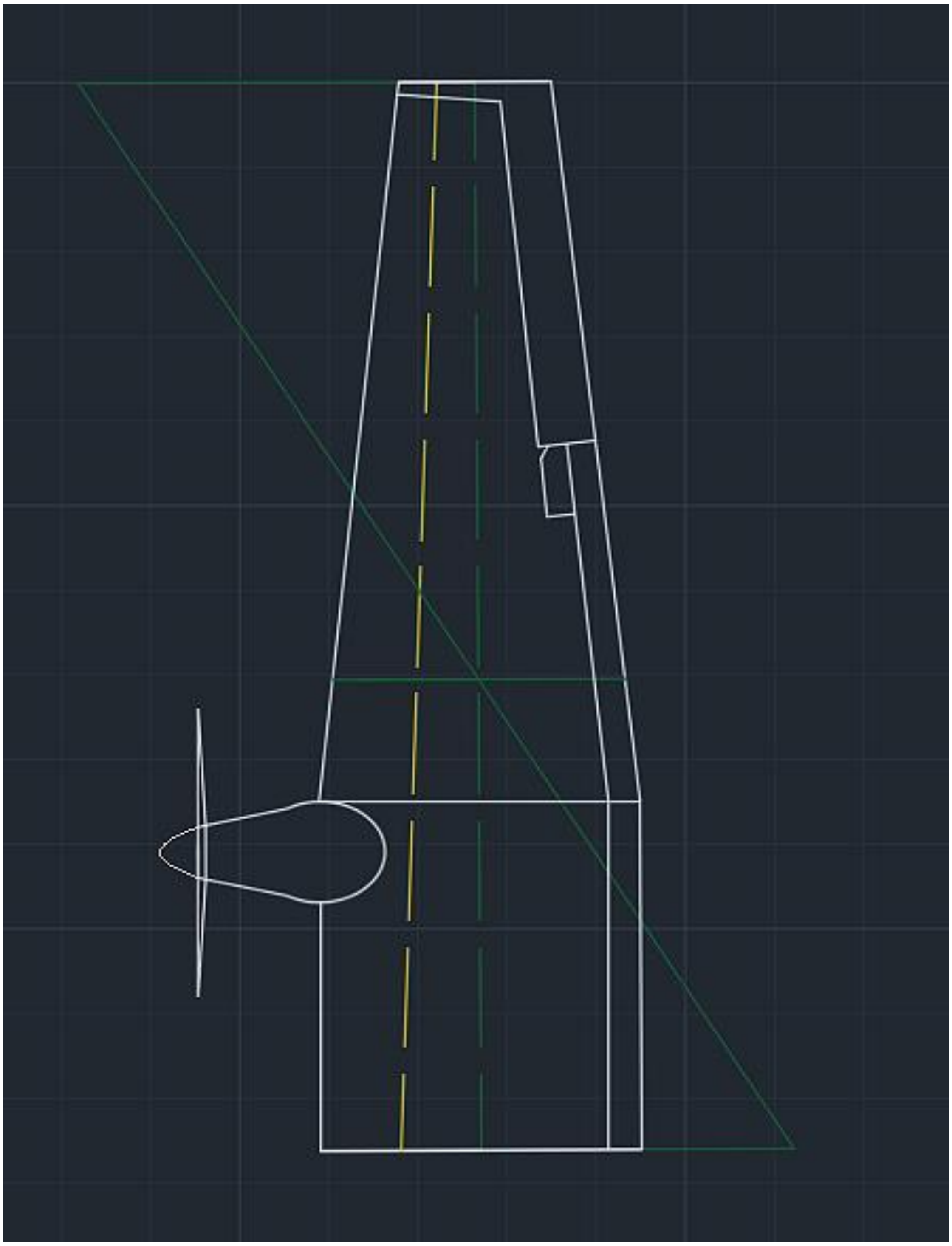

Fig. 2.2. Top view of a wing

2.2. Fuselage layout

Generally, the fuselage layout estimation consists of main geometrical dimensions calculation and interior scheme creation. Fuselage layout consists of a comfortable accommodation of passengers in the cabin. The fuselage structure is composed of bulkheads (formers and frames), stringers (longerons), and skin. Formers determine the fuselage shape and provide support for the stringers and skin. These formers are installed in parallel and linked with stringers. Frames bear the primary loads, including concentrated forces from the wing, tail, landing gear attachment, near entrance and emergency exits, and cargo doors (fig. 2.3)

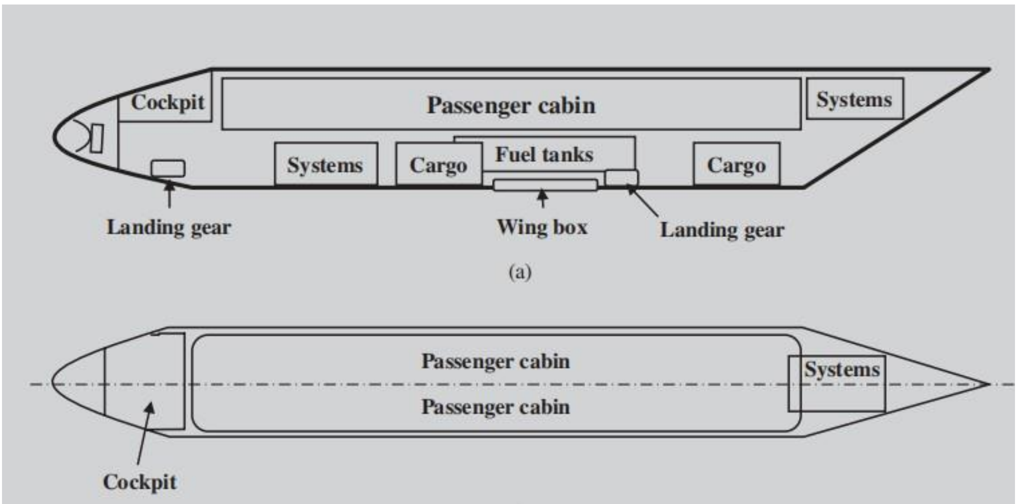

Fig. 2.3. Preliminary design of aircraft layout

1. Length of the aircraft fuselage:

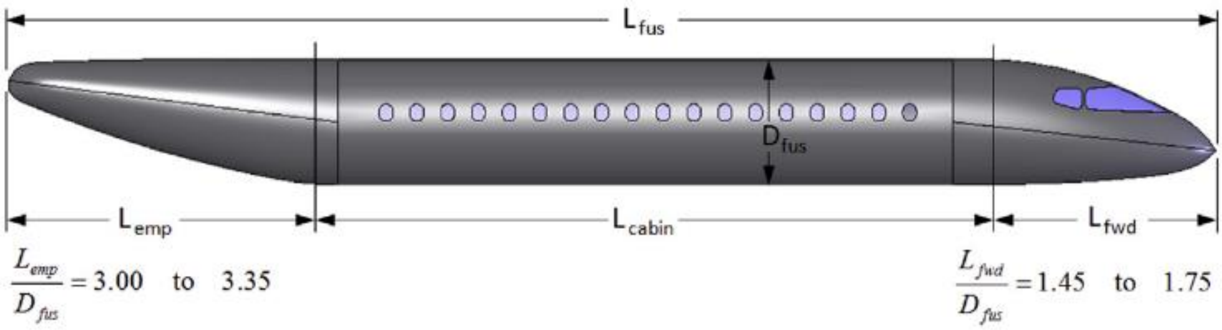

Fig. 2.4. Fuselage geometry

$$FR = L_{fus} \cdot D_{fus}$$

$$L_{fus} = FR \cdot D_{fus} = 7.5 \cdot 2.8 = 21 \text{ m}$$

where FR – fineness ratio of the fuselage (from initial data)

D_{fus} – diameter of the fuselage (from initial data)

2. Length of aircraft fuselage forward part:

$$L_{fwd} = \frac{27 \cdot 1.7}{14} = 3.3 \text{ m}$$

3. Length of the fuselage tail part:

$$L_{tail\ part} = 21 - 3.3 - 11 = 6.7 \text{ m}$$

4. Cabin width.

The cabin width of passenger aircraft in a place where we have passenger's seats can be found by the formula:

$$B_{cabin} = n_2 b_2 + n_3 b_3 + n_{ailse} b_{ailse} + 2\delta + 2\delta_{wall}$$

n_2; n_3 – number of blocks of seats with 2 or 3 seats in a cross section;

b_2; b_3 – width of block of 2 seats or 3 seats, mm;

n_{aisle}– number of aisles;

b_{aisle}- aisle width, mm;

δ – distance between external armrests to the decorative panels, mm;

(minimum 50 mm for the 1st class, minimum 30 mm for others classes)

δ_{wall}= 80…120 – width of the wall (fuselage structure, insolation, decorative panels), mm.

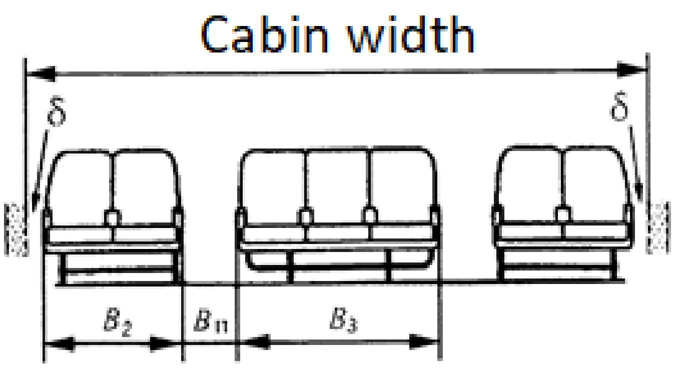

Fig. 2.5. Gaps between panels and armrests

Aisle width is defined in CS 25.815.

Table 2.1

Aisle width for the transport category aircraft

Number of passenger's seats	Minimum aisle width for passengers, mm	
	from the floor distance less than 635 mm	More than above 635 from the floor
10 and less	305*	381
11…19	305	508
20 and more	380**	508**

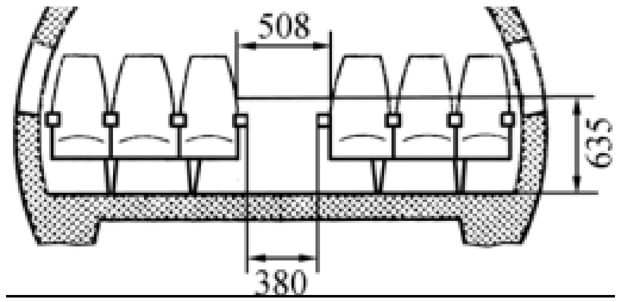

Fig. 2.6. Minimum aisle width

According to the recommendations and on the base of statistic data of prototypes the width of aisle can be taken from the next table. 2.4

Table 2.2

Statistic data for the width of aisle for transport category of the aircraft

Class of passenger cabin	Economy	Business	First	
Flight duration, hours.	Up to 4	Up to 10	Up to 6	6…12
Aisle width at the level of 635 mm from the floor, mm	400…510	500…600	600	800

$$B_{cab} = 2 \cdot 1040 + 480 + 160 = 2720 \text{ mm}$$

5. Cabin height.

Cabin height is:

$$H_{cab} = 1.48 + 0.17 \cdot 2.72 = 1.9 \text{ m}$$

Windows are placed in one row on each side of the fuselage. The shape of windows are rectangular with rounded corners. Because aircraft windows are easily leading to stress concentration, the corners of the windows are rounded. The windows located between two bulkhead and in my design, the distance between two windows is about 550 mm.

6. Length of the cabin

The passenger seats are installed along the length of the passenger cabin with correct seat pitch, which depend on the flight duration and class of the cabin. Seat pitch must be divisible to one inch. (25.4 mm).

Cabin length $L_{cab.}$ for typical accommodation with constant seat pitch L_{seat}

$$L_{cab} = L_1 + (N-1)L_{seat} + L_2$$

L_1 - distance from the wall to the back of the seat in first row, mm;

L_2 - distance from the back of the seat in the last row to the wall, mm.

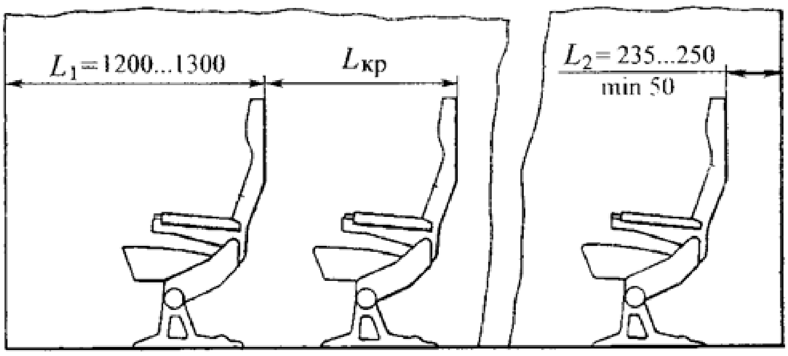

Fig. 2.7. Cabin length definition

The length of economic passenger cabin:

$$L_{cabin} = 1200 + (13 - 1)800 + 235 = 11035 \; mm \approx 11 \text{ m}$$

7. Baggage compartment

Baggage compartments are placed under the floor of passenger cabin. It is important in the flight which will influence gravity center of the aircraft. Incorrect placement of cargo and passengers, can lead to emergency situations in flight, that is why we have to calculate exactly cargo placement and limit their weight.

Given the fact that the unit of load on floor K = 400…600 kg/m²

The area of cargo compartment is defined:

$$S_{cargo} = \frac{M_{bag}}{0.4K} + \frac{M_{cargo\ and\ mail}}{0.6K} = \frac{15 \cdot 52}{0.4 \cdot 600} + \frac{10 \cdot 52}{0.6 \cdot 600} = 5\ \mathrm{m}^2,$$

where M_{bag} – mass of baggages of all passengers, M_{bag}=m n_{pass}, m- mass of baggage for one passenger for free, n_{pass} – number of passengers.

$M_{cargo\ \&mail}$ – mass of additional cargo and mails on the board of aircraft., approximately 15 kilograms for each passenger.

Cargo compartment volume is equal:

$$V_{cargo} = \nu \cdot n_{pass} = 0.2 \cdot 52 = 10.4\ \mathrm{m}^3$$

Luggage compartment design similar to the prototype

8. Galleys and buffets

According to international standards, the volume of the galleys should be about 0.1 cubic meter per passenger, so the volume of galley should be:

$$V_{galley} = 0.1 \cdot n_{passenger} = 0.1 \cdot 52 = 5.2\ \mathrm{m}^3$$

The total area of galley floor:

$$S_{galley} = \frac{V_{galley}}{H_{cab}} = \frac{5.2}{1.9} = 2.88\ \mathrm{m}^2$$

Buffet design similar to prototype.

9. Lavatories

Number of toilet facilities is determined by the number of passengers and flight duration: with

$t > 4{:}00$ one toilet for 40 passengers,

$t = 2 \ldots 4$ hours and 50 passengers,

$t < 2$ hours to 60 passengers.

$$t = \frac{Range_{flight}}{V_{cruise}} + 0.5 = \frac{1300}{520} + 0.5 = 3 \text{ h}$$

$$N_{lavatory} = \frac{N_{passenger}}{50} = \frac{52}{50} > 1$$

The number of lavatories I choose according to the original airplane and it is equal 4.

Area of lavatory:

$$S_{lav} = 1.5\text{m}^2$$

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

On my aircraft, 1 galley and 1 lavatory are designed. Galley and lavatory design are similar to the prototype, galley and lavatory layout are shown in fig. 2.8. And preliminary design of aircraft layout is shown in fig. 2.9.

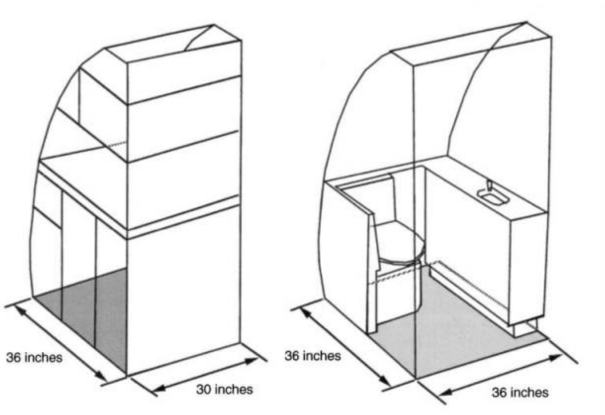

Fig. 2.8. Design of galley and toilet

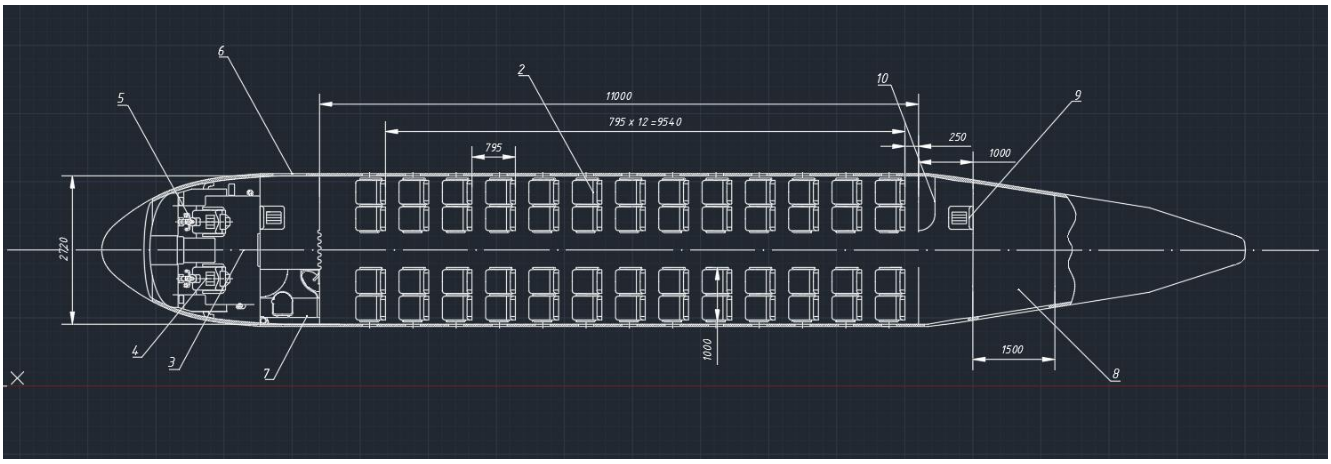

Fig. 2.9. Preliminary design of aircraft layout

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2.3. Layout and calculation of basic parameters of tail unit.

Provides statistical data for the range of static moment coefficients (Ahtu for the horizontal tail unit and Avtu for the vertical tail unit) along with typical arm lengths relative to the mean aerodynamic chord of the wing. This information assists in the initial estimation of geometric parameters To outline the overall dimensions of the tail unit accurately, it’s essential to calculate the geometrical aspects of both the vertical and horizontal stabilizers, including the dimensions of control surfaces. Ultimately, the tail

1. Usually the areas of vertical SVTU and horizontal SHTU of TU is:

$$S_{HTU} = \frac{2.5123 \cdot 68}{9} \cdot 1.1 = 20.88 \text{ m}^2$$

$$S_{VTU} = \frac{25 \cdot 68}{4.5} \cdot 0.05 = 18.8 \text{ m}^2$$

So as the result take S_{HTU} =20.88 m^2 and S_{VTU} = 18.8 m^2,

where L_{HTU} and L_{VTU} - arms of horizontal TU and vertical TU.

l, S – wing span and wing area.

Values L_{HTU} and L_{VTU} depend on some factors. First of all, their value are influenced by: the length of the nose part and tail part of the fuselage, sweptback and wing location, and also from the conditions of stability and control of the airplane.

In the first approach we may count that $L_{HTU} \approx L_{VTU}$ and we may find it from the dependences:

Trapezoidal scheme, normal scheme $L_{VTU} = (0.2..3.5) b_{mac}$

Light airplane $L_{HTU} = (2.0..2.3) b_{mac}$

Heavy airplane $L_{HTU} = (3.2..3.3) b_{mac}$

2. Determination of the elevator area and direction:

elevator area:

$$S_{el} = (0.3..0.4) S_{HTU} = 0.3 \cdot 20.88 = 6.26 \text{ m}^2$$

3. Rudder area:

$$S_{rudder} = (0.2..0..22) S_{VTU} = 0.21 \cdot 18.88 = 3.96 \text{ m}^2$$

4. Choose the area of aerodynamic balance.

$$0.3 \le M \le 0.6$$

$$S_{ab\ el} = (0.22.0.25)S_{el} = 0.23 \cdot 6.26 = 1.4 \text{ m}^2;$$
$$S_{ab\ rudder} = (0.2..0.22)S_{rudder} = 0.2 \cdot 3.96 = 0.79 \text{ m}^2;$$
$$S_{trim\ \tan\ rudder} = 0.05 \cdot 3.96 = 0.198 \text{ m}^2;$$
$$S_{trim\ tab\ el} = 0.09 \cdot 6.26 = 0.5634 \text{ m}^2$$

5. Determination of the TU span.

TU span is related to the following dependence:

$$l_{HTU} = (0.32..0.5)l_{wing} = 25/3.62 = 6.91 \text{ m}$$

In this dependence the lower limit corresponds to the turbo jet engine aircraft, equipped with all-moving stabilization.

The height of the vertical TU h_{vtu} is determined accordingly to the location of the engines. Taking it into account we assume:

6. Engine in the root part of the wing

$$h_{VTU} = (0.13..0.165)l_w = 25/4.46$$

For high wing airplanes we need to set the upper limit.

7. Tapper ratio of horizontal and vertical TU we need to choose:

For planes

$$M < 1 \eta_{htu} = 1.5 \eta_{vtu} = 1.37$$

8.TU aspect ratio

We may recommend:

For transonic planes $\lambda_{VTU} = 0.88;\ \Delta HTU = 3.16$

Determination of TU chords b_{end}, b_{CAX}, b_{root}:

$$b_{tip} = \frac{2S_{HTU}}{(\eta_{htu}+1)l_{htu}} = 2.05 \text{ m},$$

$$b_{mac} = 0.66 \frac{\eta^2_{htu} + \eta_{htu} + 1}{\eta_{htu} + 1} \cdot b_{htu\ tip} = 2.57,$$

$$b_{root} = b_{tip} \cdot \eta_{htu} = 3.85 \text{ m}.$$

Width/chord ratio of the airfoil.

For horizontal and vertical TU in the first approach, $\overline{C}_{TU} \approx 0.8\overline{C}_w$.

For more accurate:

Subsonic $\overline{C}_{TU}$ =0.08...0.10

If the stabilizations fixation is on the fin, we need to use upper limit of $\overline{C}_{TU}$, to provide fixation base on the fin.

9. TU sweptback.

TU sweptback is taken in the range 3..5°, and not more than wing sweptback. We do it to provide the control of the airplane in shock stall on the wing.

2.4. Calculation of basic parameters and layout of landing gear.

In the primary stage of design, when the airplane center-of-gravity position is not defined and there is no drawing of airplane general view, only the part of landing gear parameters may be determined. It is shown in the fig.2.9.

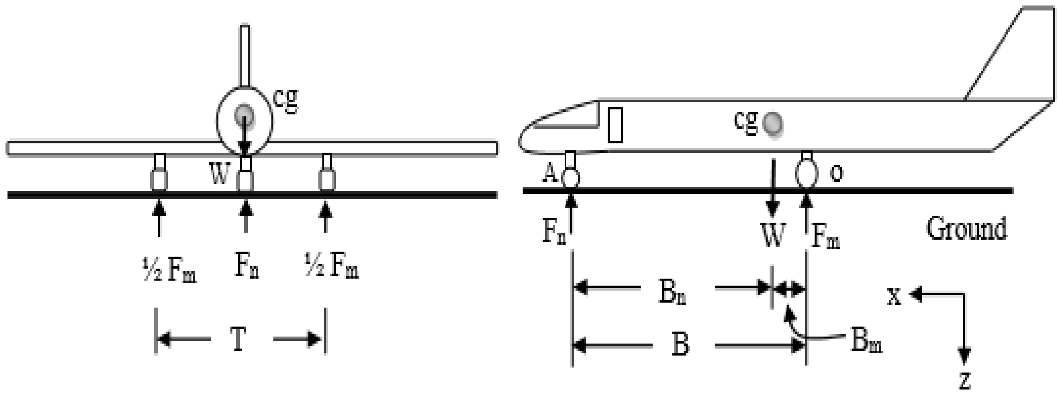

Fig. 2.10. Landing gear parameters

1. The distance from the centre of gravity to the main LG

$$B_m = (0.15..0.20) b_{MAC} = 0.15 \cdot 2.51 = 0.38 \approx 0.4 \text{ m}$$

With the large distance the lift of the nose gear during take of is complicated, and with small, the strike of the airplane tail is possible, when the loading of the back of the airplane comes first. Besides the load on the nose LG will be too small and the airplane will be not stable during the run on the slickly runway and side wind.

Landing gear wheel base comes from the expression:

$$B = (0.3..0.4) l_f = (6..10) B_m$$

The (k = 2.53) is the coefficient from my prototype. Large value belongs to the airplane with the engine on the wing. The last equation means that the nose support carries 6..10 % of aircraft weight.

2. The distance from the centre of gravity to the nose LG

$$B_n = B - B_m = 8 - 0.4 = 7.6 \text{ m}$$

3. Wheel track is:

$$T = (0.7..1.2)B \leq 12 \text{ m};\ T = 4.1 \text{ m}$$

On a condition of the prevention of the side nose-over the value T should be > 2H, where H – is the distance from runway to the center of gravity.

Wheels for the landing gear is chosen by the size and run loading on it from the take off weight; for the front support we consider dynamic loading also.

Type of tires and the pressure in it is determined by the runway surface, which should be used. We install breaks on the main wheel, and sometimes for the front wheel also.

The load on the wheel is determined:

$$W = 20676 \cdot 9.8 = 202624.8$$
$$F_n = 1822.5261\ lbs = 826.44 \text{ kg};$$
$$F_m = 11543.264801\ lbs = 5235.82 \text{ kg};$$

$$F_{main} = \frac{(B - B_m)m_0 \cdot 9.81}{B \cdot n \cdot z} = \frac{(8 - 0.4)22061 \cdot 9.81\frac{m}{s}}{8 \cdot 2 \cdot 2} = 51347 \text{ N}$$

$$F_{nose} = \frac{B_m \cdot m_0 \cdot 9.81 \cdot K_g}{B \cdot z} = \frac{0.4 \cdot 22061 \cdot 9.81 \cdot 1.5}{8 \cdot 2} = 8107 \text{ N}$$

For ensuring of airplane pass ability, used on the ground runways, pressure in the wheel pneumatics should range in $P = 4 \cdot 10^5\ Pa$. Main landing gear tyre is Rib 461B-2515-TL, loading rate is 96 %. Nose landing gear tyre is Flight Custom II 156E66-1, loading rate is 93.5 %.

2.5. Choice and description of power plant

For the aircraft, 2 power plants of the Pratt & Whitney Canada PW127G type are chosen. Pratt & Whitney Canada PW127G (shown in picture 2.8) is a turboprp aircraft engine, part of the PW 100 series. It is primarily used on the ATR's aircrafts. The PW127G features advanced technologies for improved fuel efficiency, reduced emissions, and lower noise levels.

The engines characteristics are such:

Thermo. Power: 3400 hp

Mech. Power: 3100 hp

Height 790 mm

Length: 2100 mm

Width 640 mm

Weight: 418 kg

The engine is known for its reliability, efficiency, and performance, making it suitable for a range of commercial aircraft applications. This is illustrated in the fig. 2.8.

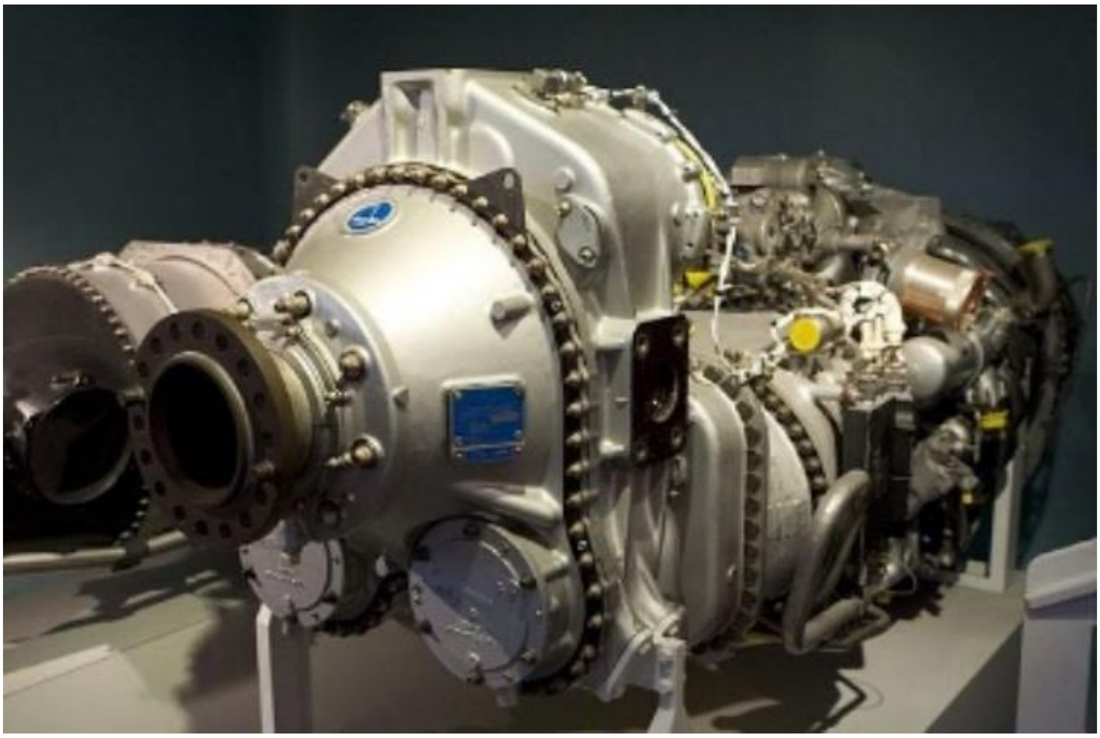

Fig. 2.11. Pratt & Whitney Canada PW127G

2.6. Determination of centering of the equipped wing

The centering is the distance from the main aerodynamic chord to the center of gravity of the airplane. The position of the aircraft's center of gravity changes due to variations in the aircraft's loading or weight during flight. The center of mass position also changes when the cargo inside the aircraft is moved. Masses what need for centering wing in the table 2.3. Coordinates of the center of gravity for the equipped wing are:

$$x'_i = \frac{\sum m'_i}{\sum m'_i}$$

Table 2.3

Object name	Mass		C.G coordinatesXi m	Mass moment,Xi · mi
	units	total massm(i), kg		
wing (structure)	0.11761	2594.59421	1.0793	2800.345531
fuel system	0.0038	83.8318	1.06675	89.42757265
Flight control system , 30 %	0.00321	70.81581	1.506	106.6486099
electrical equipment, 10 %	0.003	66.183	0.251	16.611933
anti-ice system , 40 %	0.00988	217.96268	0.251	54.70863268
hydraulic systems, 30 %	0.0182	401.5102	1.506	604.6743612
power plant	0.14285	3151.41385	-1.3	-4096.838005
equipped wing without landing gear and fuel	0.29855	6586.31155	-0.064439916	-424.4213648
fuel	0.13279	2929.48019	1	2929.48019
total	0.43124	9515.79174	0.263252801	2505.058825

2.7. Determination of the centering of the equipped fuselage

The origin for the coordinates of fuselage equipment is chosen to be the nose of the fuselage on the horizontal axis. The list of the equipped objects on the fuselage is given in the table. 2.4.

Table 2.4

N	objects names	Mass		C.G coordinates, m	mass moment
		units	total mass		
1	2	3	4	5	6
1	fuselage	0.11717	2584.88737	10	25848.8737
2	horizontal tail	0.01594	351.65234	18	6329.74212

Ending the table 2.4

1	2	3	4	5	6
3	vertical tail	0.01631	359.81491	17	6116.85347
4	nose landing gear	0.004179	92.192919	1.5	138.2893785
5	main landing gear	0.037611	829.736271	9.5	7882.494575
6	radar	0.0046	101.4806	0.5	50.7403
7	radio equipment	0.0034	75.0074	1	75.0074
8	instrument panel	0.008	176.488	1.2	211.7856
9	aero navigation equipment	0.0068	150.0148	1.3	195.01924
10	Flight control system 70%	0.00749	165.23689	10.5	1734.987345
11	hydraulic system 30%	0.0078	172.0758	14.7	2529.51426
12	electrical equipment 90%	0.027	595.647	10.5	6254.2935
13	bagage equipment in the nose part	0.00585	129.05685	16	2064.9096
14	bagage equipment in the tail	0.00585	129.05685	3	387.17055
15	lining and insulation	0.0107	236.0527	9	2124.4743
16	anti ice system, 20%	0.00494	108.98134	13	1416.75742
17	airconditioning system, 40%	0.009880	217.96268	10	2179.6268
18	passenger seats (economic class)	0.015865101	350	11	3850
19	seats of flight attendence	0.000453289	10	4	40
20	seats of pilot	0.0014	30	1.48	44.4
21	Emergency equipment	0.0019217	42.3956	1.5	63.5934
22	lavatory1, galley 1	0.0023	50.7403	3	152.2209
23	lavatory2, galley 2	0.0023	50.7403	17	862.5851
24	Operational items	0.01757	387.61177	3	1162.83531
25	**equipped fuselage without payload**	**0.33529**	**7396.83269**	**9,69552473**	**71716.174**
26	Passengers(economy)	0.1813154	4000	13	44000
27	on board meal	0.0022664	50	18	500
28	baggage	0.0235718	520	18	5200
29	cargo, mail	0.0153281	338.155	13	3381.55
30	flight attend	0.0045328	100	4	400
31	crew	0.0063460	140	1.5	210
32	TOTAL	0.56865	12544.98769	9.996	125407.72

After determination of wing and fuselage equipped masses, the moment equilibrium equation relatively to the fuselage nose is constructed:

$$m_f x_f + m_w\left(x_{MAC} + x'_w\right) = m_0\left(x_{MAC} + C\right)$$

Then, MAC leading edge position relative to fuselage X MAC value by formula:

$$x_{mac} = \frac{m_f x_f + m_w - x'_w - n_{0C}}{m_0 - mw} = 10.38938851,$$

where m0 is aircraft takeoff mass, kg; m f mass of fully equipped fuselage. kg;

mw is mass of fully equipped wing, kg;

C is the distance from MAC leading edge to the point of center of gravity and is determined by the formula C = (0.23..0.32)Bmac

2.8. Calculation of center of gravity positioning variants

The list of all equipped masses for calculation given in Table 3.3 and the center of gravity calculation options are given in table 3.4. which are created on the basis of table 2.5 and table 2.6.

Table 2.5

Name	mass in kg	coordinate	mass moment
object	m_i	X_i, м	kgm
equipped wing (without fuel and landing gear)	6586.31	10.33	68036.6
Nose landing gear (extended)	92.2	2.0	184.4
main landing gear (extended)	829.74	11.5	9542
fuel reserve	702.6	12	8431.2
fuel for flight	2226.8	12	26721.6
equipped fuselage (without payload)	6474.89	9.84	63695.4
Passengers(economy)	4000	13	52000
on board meal	50	18	900
baggage	520	18	9360
cargo, mail	338.155	13	4396
flight attend	100	4	400
crew	140	1.5	210
Nose landing gear (retrected)	92.2	1	92.2
main landing gear (retrected)	829.74	11.5	9542

Table 2.6

№	Name of the object	Mass, m_i kg	mass moment m_iX_i	center of mass $X_{цм}$	Centering, %
1	take off mass (L.G. extended)	22061	243877	11.05	26.3
2	take off mass (L.G. retracted)	22061	243785	11.05	26.3
3	landing weight (LG extended)	19834	217155	10.95	22.3
4	ferry version (without payload, max fuel, LG retracted)	17053	185025	10.85	18.3
5	parking version (without payload, without fuel foe flight, LG extended)	14124	152115	10.77	15.1

Conclusion to the project part

This section provides a detailed geometric analysis of the airframe components of the proposed aircraft, based on the chosen ATR 42 prototype. A particular emphasis was placed on achieving a balance between aerodynamic efficiency, structural simplicity, and compliance with contemporary requirements for short-haul passenger transport.

The wing geometry calculations involved determining key dimensions such as span, chord at the root and tip, area, elongation, and sweep. These calculations formed the basis for the design of a wing with an optimal lift-to-drag ratio, ensuring efficient cruising and sufficient maneuverability during take-off and landing.

The fuselage layout was designed to accommodate the passenger compartment, nose section, cockpit, galley, and lavatory at the required lengths. The fuselage proportions have been designed with seating for 52 passengers, with a focus on minimizing aerodynamic drag and positioning the cargo compartment in the tail section.

The geometric parameters of the horizontal and vertical stabilizers were determined for the wings, including their area, root and tip chord lengths, and the shape and height of the arrow. The configuration of the layout was determined by the necessity to ensure stability and controllability at all stages of flight.

3. ADDITIONAL LUGGAGE SPACE

3.1. Upward growth trend

For thousands of years, human height has remained relatively stable, not exceeding the average of 170 cm. This was true primarily in the pre-industrial period, before the emergence of modern economic structures and globalised agriculture. However, starting in the Neolithic era, when humanity switched from a hunter-gatherer lifestyle to settled agriculture, the average height began to decline. The reasons for this were a monotonous diet, reduced protein intake, frequent infectious diseases and deteriorating living conditions in overcrowded settlements.

Historical and anthropological evidence suggests that in pre-agricultural times - particularly in the Paleolithic and Mesolithic periods - some populations of people were often taller than the current average. For example, hunter-gatherers in Europe and India often reached 183 cm for men and over 170 cm for women.

However, with the onset of the Bronze Age, the situation became heterogeneous: the average height varied significantly depending on the region. For example, the Indus Valley residents had some of the highest figures at the time - about 176 cm for men, while in ancient Egypt this figure was 167 cm. The ancient Greeks and Romans were slightly shorter, although the Romans were slightly superior to the Greeks in terms of average height.

Until the eighteenth century, there were only minor fluctuations - height varied cyclically, but generally remained within +/- a few centimetres. In the eighteenth and nineteenth centuries, against the backdrop of industrialisation and urbanisation, many countries in Europe and North America saw a further decline in height, which was later called the ‘industrial paradox’: despite technological progress and economic growth, the living conditions of the majority of the population were deteriorating, leading to a decrease in anthropometric indicators.

One of the most striking examples is England in the early nineteenth century, where the difference in height between the elite (graduates of military academies) and the working class reached a record 22 cm. At the same time, regional differences in the world were insignificant until the end of the nineteenth century, with the most prominent differences being in Southeast Asia (shorter) and Anglo-Saxon regions (taller).

However, starting in the late nineteenth century and throughout the twentieth century, the situation changed. In the more developed countries of the world, there has been a steady increase in average height. This was driven by improvements in nutrition, hygiene, healthcare and living conditions. Over the past 150 years, the average height in industrialised countries has increased by about 10 cm. However, today this trend has largely stabilised.

The current situation in Korea is a vivid example of the difference in height caused by economic conditions. Numerous studies have shown that the average height of South Koreans is significantly higher than that of their North Korean peers who grew up in the 1990s, during the DPRK famine. The difference was more than 12 cm, which is directly linked to prolonged malnutrition and protein deficiency. The same generations born before the collapse of the North and South economies had virtually no such differences. It is shown in fig. 3.1.

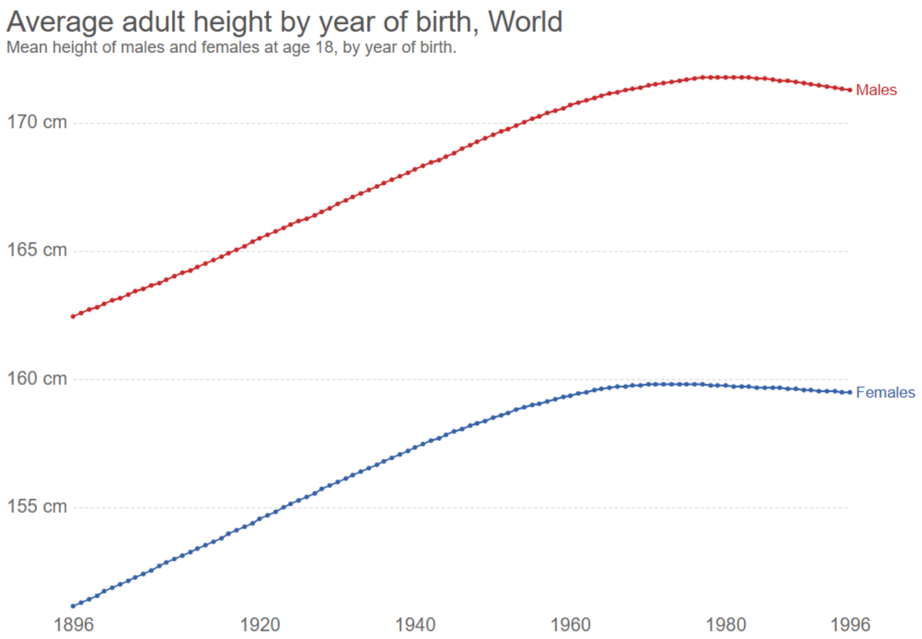

Fig. 3.1. Average adult height by year of birth

3.2. Percentile value

A percentile is a way of comparing a single value to an entire group of people or data. it shows how many percent of people have less than or the same value as the specified value. for example, if a person's height is in the fifth percentile, it means that only five percent of people are shorter and ninety-five percent are taller. If a person's height is at the fiftieth percentile, it means that they are average, with half the people being shorter and half being taller. if a person's height is at the ninety-fifth percentile, it means that they are taller than ninety-five per cent of the other people. As example of percentile is shown in fig. 3.2.

Buttock-Knee Length

	FEMALE N = 2208			MALE N = 1774	
Centimeters		Inches	Centimeters		Inches
58.89	Mean	23.19	61.64	Mean	24.27
2.96	Std Dev	1.17	2.99	Std Dev	1.18
69.10	Maximum	27.20	72.30	Maximum	28.46
49.10	Minimum	19.33	50.60	Minimum	19.92
	Percentiles			Percentiles	
52.18	1st	20.54	55.07	1st	21.68
53.03	2nd	20.88	55.81	2nd	21.97
53.54	3rd	21.08	56.28	3rd	22.16
54.21	5th	21.34	56.90	5th	22.40
55.20	10th	21.73	57.87	10th	22.78
55.87	15th	22.00	58.54	15th	23.05
56.39	20th	22.20	59.08	20th	23.26
56.85	25th	22.38	59.55	25th	23.45
57.27	30th	22.55	59.98	30th	23.62
27.66	35th	22.70	60.39	35th	23.77
58.04	40th	22.85	60.78	40th	23.93
58.41	45th	23.00	61.16	45th	24.08
58.78	50th	23.14	61.54	50th	24.23
59.15	55th	23.29	61.93	55th	24.38
59.54	60th	23.44	62.32	60th	24.54
59.95	65th	23.60	62.73	65th	24.70
60.38	70th	23.77	63.17	70th	24.87
60.85	75th	23.96	63.65	75th	25.06
61.39	80th	24.17	64.19	80th	25.27
62.01	85th	24.41	64.81	85th	25.52
62.81	90th	24.73	65.60	90th	25.83
63.98	95th	25.19	66.74	95th	26.28
64.72	97th	25.48	67.45	97th	26.56
65.24	98th	25.69	67.95	98th	26.75
66.02	99th	25.99	68.69	99th	27.04

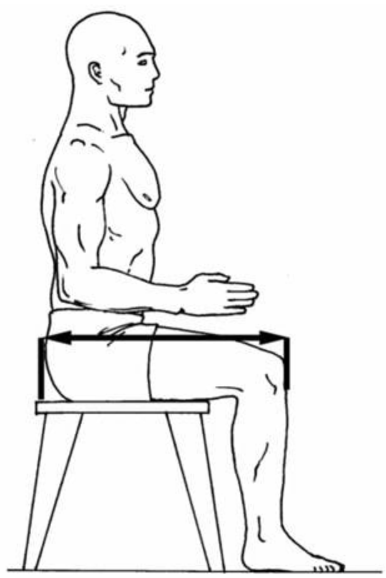

Fig. 3.2. Percentile value of buttock knee length

An example that clearly illustrates the comparative analysis of a person's full height gives a clearer understanding of an issue that has become increasingly relevant in recent years, as shown in the fig. 3.3.

Stature

FEMALE N = 2208 Centimeters		Inches	MALE N = 1774 Centimeters		Inches
162.94	**Mean**	64.15	175.58	**Mean**	69.13
6.36	**Std Dev**	2.50	6.68	**Std Dev**	2.63
187.00	**Maximum**	73.62	204.20	**Maximum**	80.39
142.80	**Minimum**	56.22	149.70	**Minimum**	58.94
	Percentiles			**Percentiles**	
148.32	1st	58.39	160.27	1st	63.10
150.18	2nd	59.13	162.05	2nd	63.80
151.31	3rd	59.57	163.17	3rd	64.24
152.78	5th	60.15	164.69	5th	64.84
154.97	10th	61.01	167.03	10th	65.76
156.43	15th	61.59	168.62	15th	66.39
157.58	20th	62.04	169.86	20th	66.88
158.58	25th	62.43	173.99	25th	67.32
159.48	30th	62.79	171.98	30th	67.71
160.32	35th	63.12	172.90	35th	68.70
161.14	40th	63.44	173.78	40th	68.42
161.93	45th	63.75	174.64	45th	68.76
162.72	50th	64.06	175.49	50th	69.09
163.53	55th	64.38	176.34	55th	69.43
164.35	60th	64.70	177.21	60th	69.77
165.21	65th	65.04	178.11	65th	70.12
166.13	70th	65.40	179.06	70th	70.50
167.13	75th	65.80	180.09	75th	70.90
168.27	80th	66.25	181.24	80th	71.35
169.59	85th	66.77	182.57	85th	71.88
171.27	90th	67.43	184.23	90th	72.53
173.73	95th	68.40	186.65	95th	73.48
175.28	97th	69.01	188.16	97th	74.08
176.39	98th	69.44	189.24	98th	74.50
178.04	99th	70.09	190.87	99th	75.14

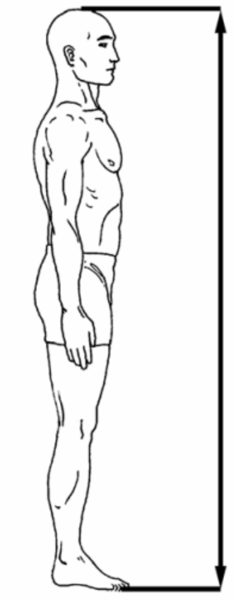

Fig. 3.3. Percentile values of total human height

Here we go in the same way. If we look at male standings, the first percentile means that only 1 % of men’s population have less value, other 99 % - more. If it is around 50 percentile that means average value. Similarly, the values are selected not only as the distance from the feet to the eyes, but also the data on the distance of the leg, the width and circumference of the human palm, the width of the hips, the lower part of the shoulder, and so on. It is worth noting that a low or high percentile does not mean that there is something wrong with a person; the percentile only shows how they look in comparison to others; it is a statistic, not a diagnosis.

Analysing the above information, it follows that over the past hundreds of years, the world's population has grown, and this trend is only going up due to high-quality and nutritious food, economic development, and significant progress in medicine and genetics.

3.3. Redistribution of passenger seats

And although, based on the percentage data presented, people who have a higher or significantly higher figure in the relevant anthropometric data still belong to the minority category of the world's population, they are still there, and coexist with us and around us.

The ATR-42 regional jet, due to its compactness, fuel efficiency, ability to take off from short runways, and low operating costs compared to other aircraft, has not much in the way of comfort. This, in turn, cannot but cause discomfort for people who, according to anthropometric data, are not so much.

Accordingly, there is a certain desire, or rather a need, to reconsider the placement of some rows of passenger seats. We are talking here about changing the seat pitch, which will allow taller people to have more legroom during the flight.

So the idea is as follows: the first three rows are subject to a redistribution of the distance along the passenger compartment relative to the other 10 rows. From the fourth to the first row, the new seat pitch will be 896 mm. and 25 mm. instead of the usual 795 mm. This will result in an increase of 101.25 mm. or 10.125 cm. In the end, 351.25 mm is a small increase, but this value significantly offsets the too small space for taller people.

In accordance with CS 25.803, which states that for aircraft with a seating capacity of more than 44 passengers, it must be demonstrated that the maximum seating capacity, including the number of crew members required by the rules of operation for which certification is sought, can be evacuated from the aircraft to the ground under simulated emergency conditions within 90 seconds. Compliance with this requirement shall be demonstrated by an actual demonstration using the test criteria set out in Annex J of this CS-25, unless the Agency determines that a combination of analysis and testing will provide data equivalent to that which would be obtained by an actual demonstration. It means, the focus is on the safety and necessary evacuation of all passengers within 90 seconds. Passenger comfort is not considered in the certification specifications.

With regard to the security situation, specifically ensuring the aircraft can depart quickly and unimpeded within 90 seconds, all the necessary equipment has been integrated. According to CS 25.807, for a passenger seating configuration of 41 to 110 seats, there must be at least two exits, one of which must be a Type I or larger exit on each side of the fuselage. In the configuration of the ATR-42 regional aircraft, the main doors, which are located in the tail section on the left side, through which passengers board directly before take-off, are also considered as emergency exits and are classified as Class 1. They meet the requirements, with parameters that do not fall below 61 cm in width and 1.22 metres in height. In the tail section of the aircraft, on the right-hand side, there are doors that meet the Type 2 standard. These also meet the requirements, with parameters that do not fall below 51 cm in width and 1.12 m in height. Both options are located at floor level. Each exit is illuminated and labelled according to the requirements for easier identification by the passenger in an emergency and nervous situation.

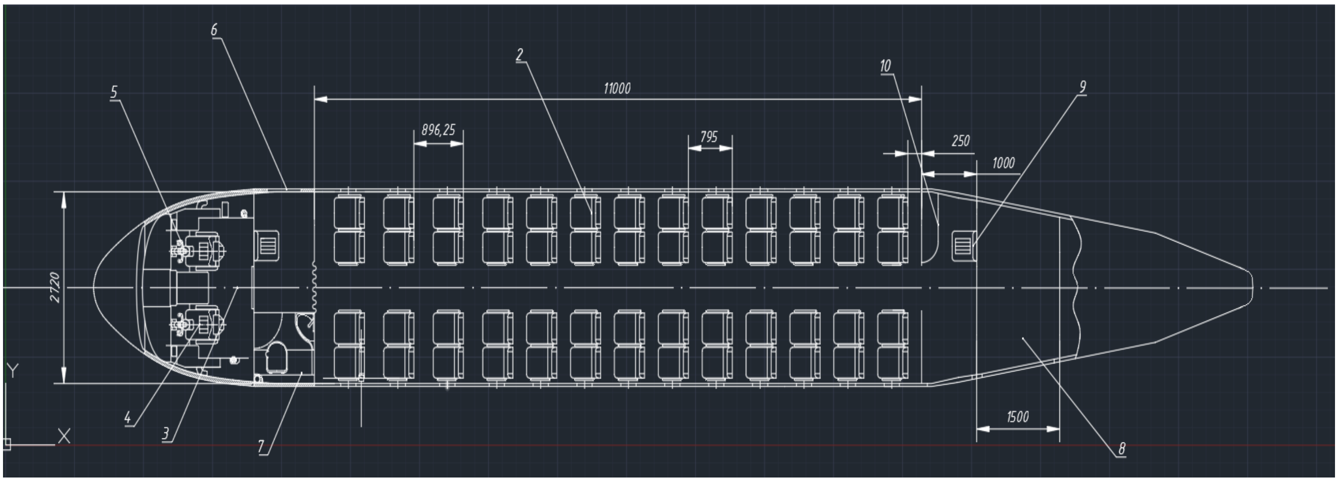

Fig. 3.4. Redistribution of passenger first rows

To increase safety during the flight, a water fire extinguisher is located in the forward cabin and a halon fire extinguisher in the rear cabin. Oxygen masks, life jackets, first aid kid, portable breathing equipment, crash axe - these and other necessary tools are kept during the operation of the vessel, they are undesirable for unauthorised use, but play a vital role in maintaining life support or saving lives in case of emergency.

3.4. Additional buggage space

Flying on a regular basis makes you adapt to it. If you have a constant need to change your position and the distance between your destinations is covered as quickly as possible by flying, you will accumulate a sufficient number of flight hours over a period of time. You want to spend your time both efficiently and in such a way that you can get to the desired destination without asking yourself how much longer I have to fly. A phone, laptop, headphones - these are the things that will allow you to spend this time without changing your position relative to the aircraft and to complete certain personal tasks. A laptop that is used and not required for a specific period of time will be a nuisance if not used. There is a need for quick access to put small items without disturbing your neighbour to reach the shelves above the passenger seats.

A life jacket is located directly below the seats, and there is a free space underneath that can be used to put your own oversized things. The standard passenger seats are shown in the fig.3.5.

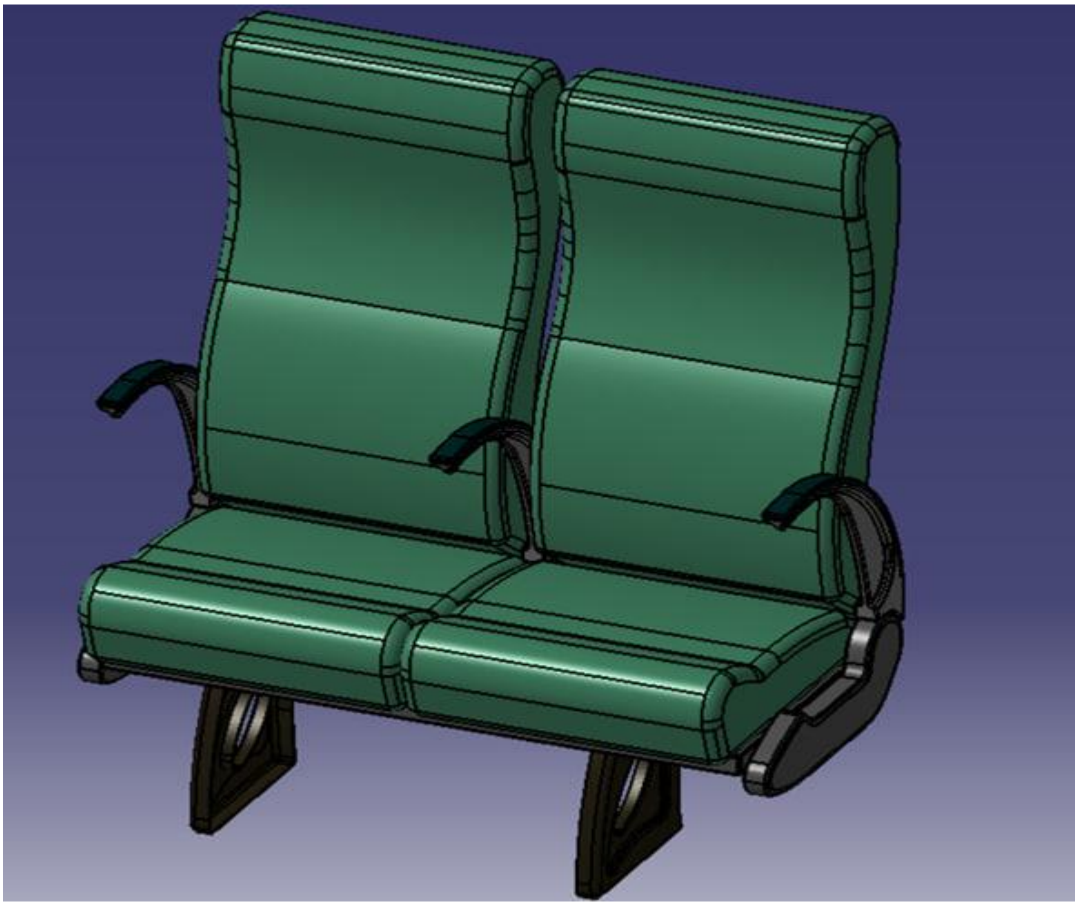

Fig. 3.5. Passenger seats

The possible improvement that could be realized is shown in the Fig.3.6.

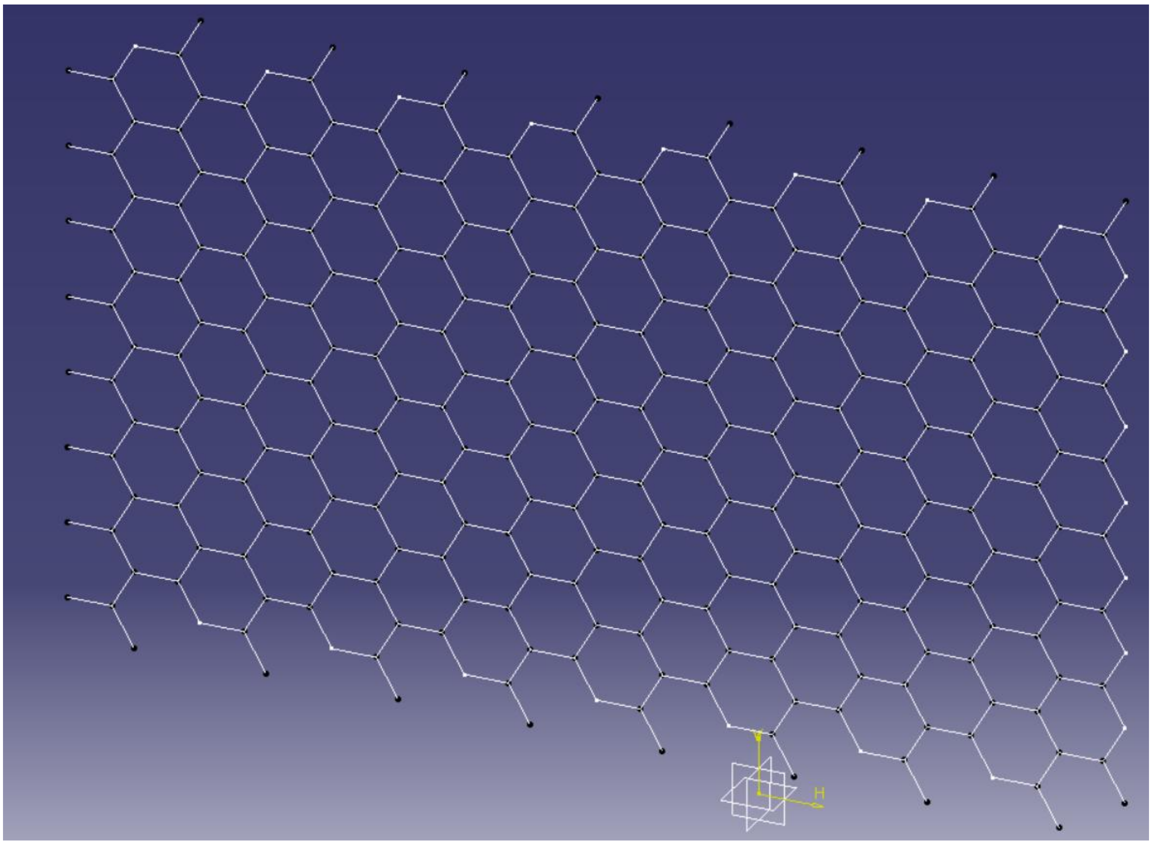

Fig. 3.6. Geometry of the mesh

A grid that can be installed under the passenger seat serves as a limited storage area for personal items such as smartphones, tablets, headphones, and documents. This solution reduces the number of small items on or near the passenger's hands, reducing the risk of them falling out, causing injury or disturbing neighbours. It is made of elastic reinforced polyester or fire-resistant nylon with polyurethane coating. The shape will be a hexagon or honeycomb, which will form a spatial flexible grid. In turn, this will have its advantages:

Weight reduction by 15-20 % compared to rectangular elements

Automatic dispersion of local loads

Aesthetic appearance that matches modern seat design

Every 4-6 fixed points along the cross-section, the mesh will be fixed with metal clamps, which in turn will be made of stainless steel. Screw fasteners with anti-vibration washers will be used, and all this will be attached to the seat legs or side brackets. The key requirements of the mesh are shown in the table 4.1.

Table 3.1

Load and strength requirements

Parameter	Value
Maximum static load	≥ 2 kg (typical tablet + phone)
Dynamic load (in flight)	≥ 5G along the aircraft axis (CS 25.561)
Fire resistance	In accordance with CS 25.853 - 60 sec at 650 °C
Service life	≥ 50,000 deformation cycles without loss of elasticity

The parameters in the table are designed to ensure the item's reliability under typical and emergency flight conditions. Static load determines the item's ability to support the weight of items that passengers most often place in this space, such as tablets, mobile phones, headphones and small bags. Dynamic load, in turn, takes into account possible overloads that may occur during turbulence, emergency braking, or hard landings. These overloads can exceed the weight of the objects many times over, so the structure must be able to withstand such conditions.

Fire resistance is an additional critical factor, as all interior elements must facilitate the evacuation of passengers within a certain timeframe in the event of a fire on board. Even details as small as mesh must meet non-flammability and non-toxicity requirements when heated to high temperatures.

It is also worth noting the requirement for a service life of more than 50,000 deformation cycles. This ensures that the element will remain suitable for long-term use without deteriorating. This characteristic is of paramount importance given that passengers will regularly put their belongings away and retrieve them.

Even seemingly insignificant interior elements require in-depth engineering justification and must comply with international aviation standards. Taking these factors into account when designing the seating layout improves passenger comfort while ensuring that the aircraft maintains its high level of safety and reliability.

Conclusions to the special part

A standard ticket for the ATR 42, a regional aircraft designed for short routes, usually costs between €80 and €150. The aircraft typically has a single-class economy layout, offering the greatest space efficiency for operators. However, this project proposes an alternative seating configuration that prioritises comfort for taller passengers and business travellers. Specifically, the layout of the first four rows, comprising 16 seats, has been redesigned to offer increased legroom by extending the seat pitch. These seats are now classified as premium economy.

Introducing a premium economy zone within the same cabin necessitates justified pricing adjustments. In practice, tickets for premium economy seating typically cost 20–50 per cent more than regular economy fares. For example, while a standard ticket might cost €100, a ticket for a seat with enhanced comfort features would cost between €120 and €170. Such pricing is consistent with current airline models and reflects improved ergonomics and service value.

In addition to the changes to the seating layout, ergonomic enhancements were introduced. All seats, regardless of class, were fitted with a flexible, netted under-seat storage solution. Although subtle, this addition to the seat structure significantly improves the travel experience by providing passengers with a personal, easily accessible place to store small items such as smartphones, headphones, and tablets. Importantly, this innovation enables passengers to access their belongings without encroaching on neighbouring travellers' space, thereby reducing disturbances and enhancing in-flight convenience.

Overall, the proposed cabin modifications are consistent with modern trends in regional aviation, where optimising cabin functionality and increasing passenger comfort must be balanced with economic feasibility and safety compliance. The design decisions reflected in this project — from reallocating seat classes to integrating personal storage elements — support a more user-centred travel experience without compromising aircraft performance or structural integrity. These enhancements demonstrate how minor interior design changes that are aligned with certification standards can contribute to the competitiveness and appeal of a regional airliner such as the ATR 42.

GENERAL CONCLUSIONS

Contemporary anthropometric trends reveal a growing discrepancy between the standard dimensions of regional aircraft cabins and the evolving physical characteristics of modern passengers. This thesis evaluates the ergonomic performance of the ATR 42 cabin in relation to the increased comfort requirements of 21^(st)-century passengers, who are, on average, taller than previous generations.

To address this challenge, the project proposes an optimised seating layout designed specifically to improve legroom for taller passengers. This involved redesigning the first four rows of the cabin to increase the seat pitch and provide more personal space, while ensuring that the overall passenger capacity was not significantly reduced. The proposed modifications were supported by a comparative analysis of comfort zones, structural implications and compliance with existing aviation safety and certification requirements.

Another key innovation developed during this project was the addition of a compact, flexible mesh pocket for storing items under the seat. Although simple in design, this feature serves two purposes: it reduces reliance on overhead compartments while providing immediate access to essential personal items such as mobile phones, headphones and small electronic devices. This improvement contributes to a smoother passenger experience and helps reduce disruption between seated individuals during the flight.

Alongside these functional updates, the project also addressed broader considerations relating to aircraft usability, load distribution and in-cabin safety during dynamic flight conditions. All design proposals were formulated in accordance with relevant regulatory frameworks, including CS-25 and FAA guidelines, to ensure engineering viability and operational realism.

In summary, this thesis sets out a comprehensive and practical approach to redesigning the interior layout of the ATR 42. By prioritising enhanced ergonomics, greater flexibility in cabin use and subtle yet meaningful improvements to passenger comfort, the resulting concept complies with technical and regulatory standards while meeting the evolving needs of passengers. This work demonstrates how targeted upgrades to aircraft interior design can boost competitiveness in the challenging, comfort-focused air travel sector.

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APPENDIX A

PRELIMINARY DESIGN OF THE AIRCRAFT

The main prototype is ATR 42

INITIAL DATA AND SELECTED PARAMETERS

Passenger Number 52.

Flight Crew Number 2.

Flight Attendant or Load Master Number 1.

Mass of Operational Items 445.48 кg.

Payload Mass 5148.00 кg.

Cruising Speed 520. kм/h

Cruising Mach Number 0.4555

Design Altitude 6.000 km.

Flight Range with Maximum Payload 1300. km.

Runway Length for the Base Aerodrome 1.68 km.

Engine Number 2.

Thrust-to-weight Ratio in N/kg 0.2810

Pressure Ratio 24.00

Assumed Bypass Ratio

Optimal Bypass Ratio

Fuel-to-weight Ratio 0.1600

Aspect Ratio 9.50

Taper Ratio 2.10

Mean Thickness Ratio 0.120

Wing Sweepback at Quarter Chord 0.000 deg.

High-lift Device Coefficient 0.580

Relative Area of Wing Extensions 0.000

Wing Airfoil Type – Laminar type by NASA

Winglets – no

`

Spoilers - yes

Fuselage Diameter 2.80 m.

Fineness Ratio 7.50

Horizontal Tail Sweep Angle 25.0 deg.

Vertical Tail Sweep Angle 35.0 deg.

CALCULATION RESULTS

Optimal Lift Coefficient in the Design Cruising Flight Point Cy 0.44258

Induce Drag Coefficient Сх.инд. 0.00976

ESTIMATION OF THE COEFFICIENT D m = M critical - M cruise

Cruising Mach Number 0.45553

Wave Drag Mach Number 0.68830

Calculated Parameter D m 0.23277

Wing Loading in kPa (for Gross Wing Area):

At Takeoff 3.220

At Middle of Cruising Flight 3.048

At the Beginning of Cruising Flight 3.152

Drag Coefficient of the Fuselage and Nacelles 0.01092

Drag Coefficient of the Wing and Tail Unit 0.00977

Drag Coefficient of the Airplane:

At the Beginning of Cruising Flight 0.03380

At Middle of Cruising Flight 0.03346

Mean Lift Coefficient for the Ceiling Flight 0.44258

Mean Lift-to-drag Ratio 13.22638

Landing Lift Coefficient 1.531

Landing Lift Coefficient (at Stall Speed) 2.296

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Takeoff Lift Coefficient (at Stall Speed) 2.040

Lift-off Lift Coefficient 1.469

Thrust-to-weight Ratio at the Beginning of Cruising Flight 0.128

Start Thrust-to-weight Ratio for Cruising Flight 0.187

Start Thrust-to-weight Ratio for Safe Takeoff 0.205

Design Thrust-to-weight Ratio No 0.211

Ratio D r = R cruise / R takeoff Dn 0.913

SPECIFIC FUEL CONSUMPTIONS (in kg/kN · h):

Takeoff 0.2702

Cruising Flight 0.2332

Mean cruising for Given Range 0.2349

FUEL WEIGHT FRACTIONS:

Fuel Reserve 0.03185

Block Fuel 0.10094

WEIGHT FRACTIONS FOR PRINCIPAL ITEMS:

Wing 0.11761

Horizontal Tail 0.01594

Vertical Tail 0.01631

Main landing Gear 0.037611

Nose landing gear 0.004179

Power Plant 0.14285

Fuselage 0.11717

Equipment and Flight Control 0.15028

Additional Equipment 0.01170

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Operational Items 0.01757

Fuel 0.13279

Payload 0.23336

Airplane Takeoff Weight = 22061. kg.

Takeoff Thrust Required of the Engine 2324.0 кВт

Air Conditioning and Anti-icing Equipment Weight Fraction 0.0247

Passenger Equipment Weight Fraction

(or Cargo Cabin Equipment) 0.0196

Interior Panels and Thermal/Acoustic Blanketing Weight Fraction 0.0107

Furnishing Equipment Weight Fraction 0.0046

Flight Control Weight Fraction 0.0107

Hydraulic System Weight Fraction 0.0260

Electrical Equipment Weight Fraction 0.0300

Radar Weight Fraction 0.0046

Navigation Equipment Weight Fraction 0.0068

Radio Communication Equipment Weight Fraction 0.0034

Instrument Equipment Weight Fraction 0.0080

Fuel System Weight Fraction 0.0038

Additional Equipment:

Equipment for Container Loading 0.0094

No typical Equipment Weight Fraction 0.0023

(Build-in Test Equipment for Fault Diagnosis,

Additional Equipment of Passenger Cabin)

TAKEOFF DISTANCE PARAMETERS

Airplane Lift-off Speed 211.63 km/h

Acceleration during Takeoff Run 2.69 m/s· s

Airplane Takeoff Run Distance 640 m

Airborne Takeoff Distance 578 m

Takeoff Distance 1219 m

CONTINUED TAKEOFF DISTANCE PARAMETERS

Decision Speed 201.05 km/h

Mean Acceleration for Continued Takeoff on Wet Runway 0.55 m/s· s

Takeoff Run Distance for Continued Takeoff on Wet Runway 873.83 м

Continued Takeoff Distance 1423.16 m

Runway Length Required for Rejected Takeoff 1469.96 m

LANDING DISTANCE PARAMETERS

Airplane Maximum Landing Weight 20676. kg

Time for Descent from Flight Level till

Aerodrome Traffic Circuit Flight 12.6 min.

Descent Distance 18.19 km.

Approach Speed 217.31 km/h

Mean Vertical Speed 1.80 m/s

Airborne Landing Distance 512 m

Landing Speed 202.01 km/h

Landing run distance 575. m

Landing Distance 1088. m

Runway Length Required for Regular Aerodrome 1816. m

Runway Length Required for Alternate Aerodrome 1544. M

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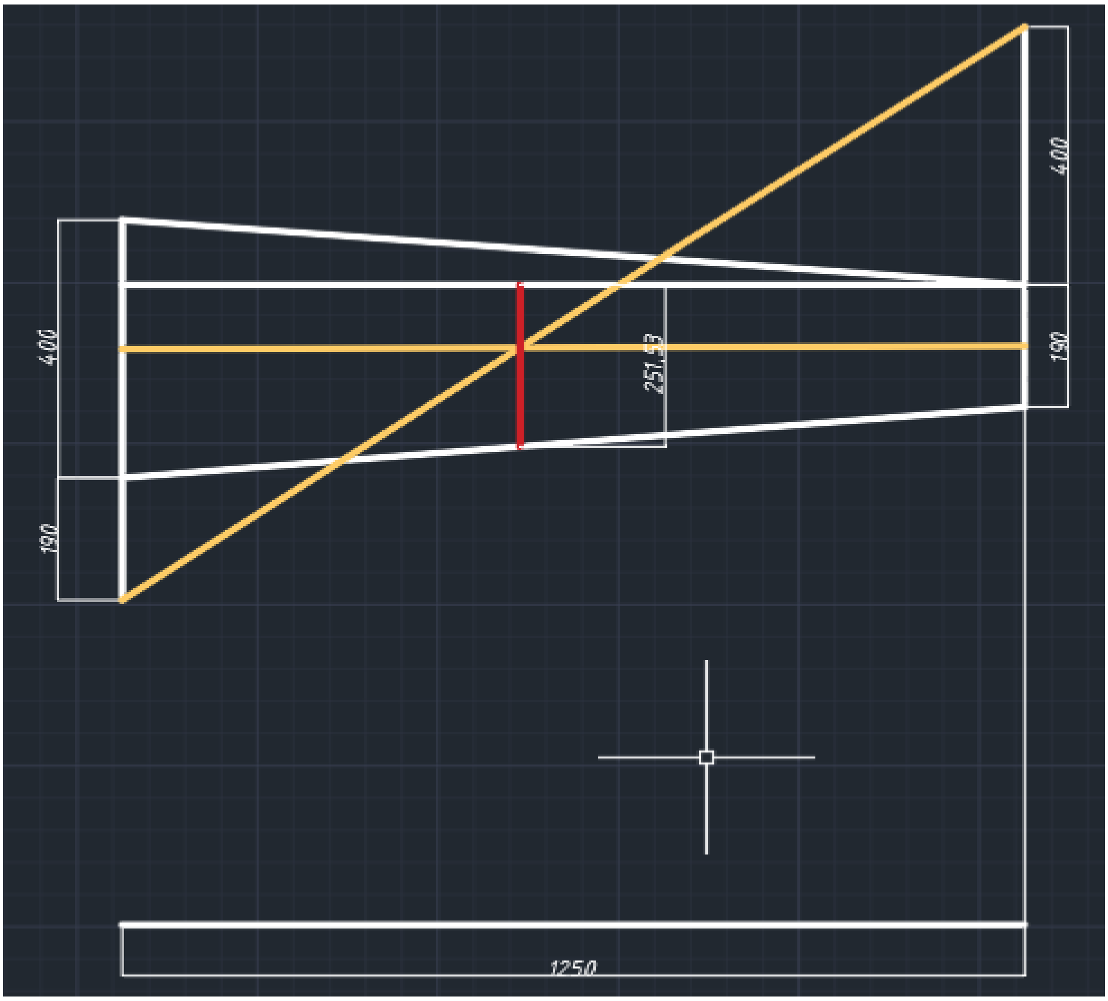
APPENDIX B

Scheme for the wing centering



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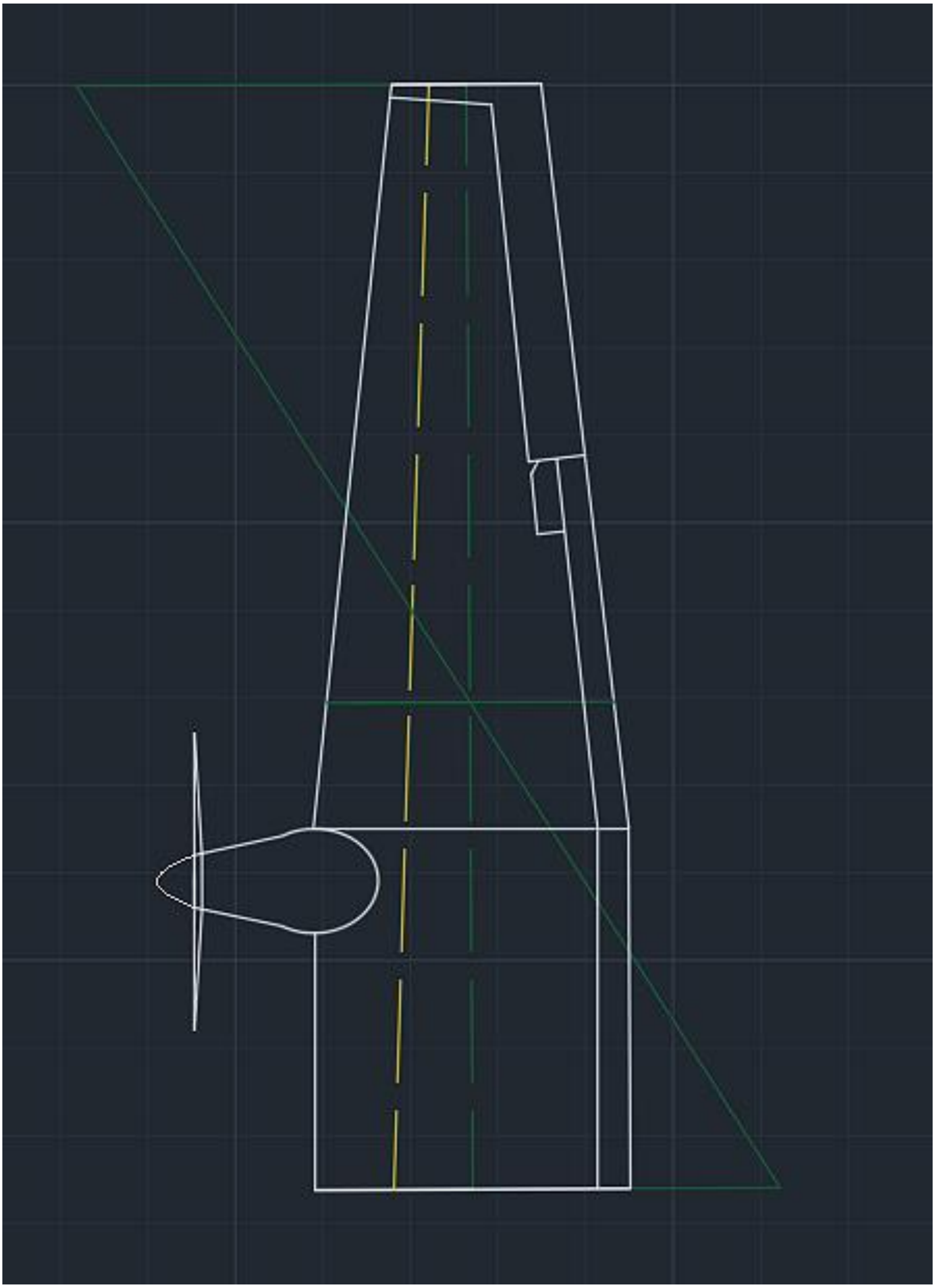
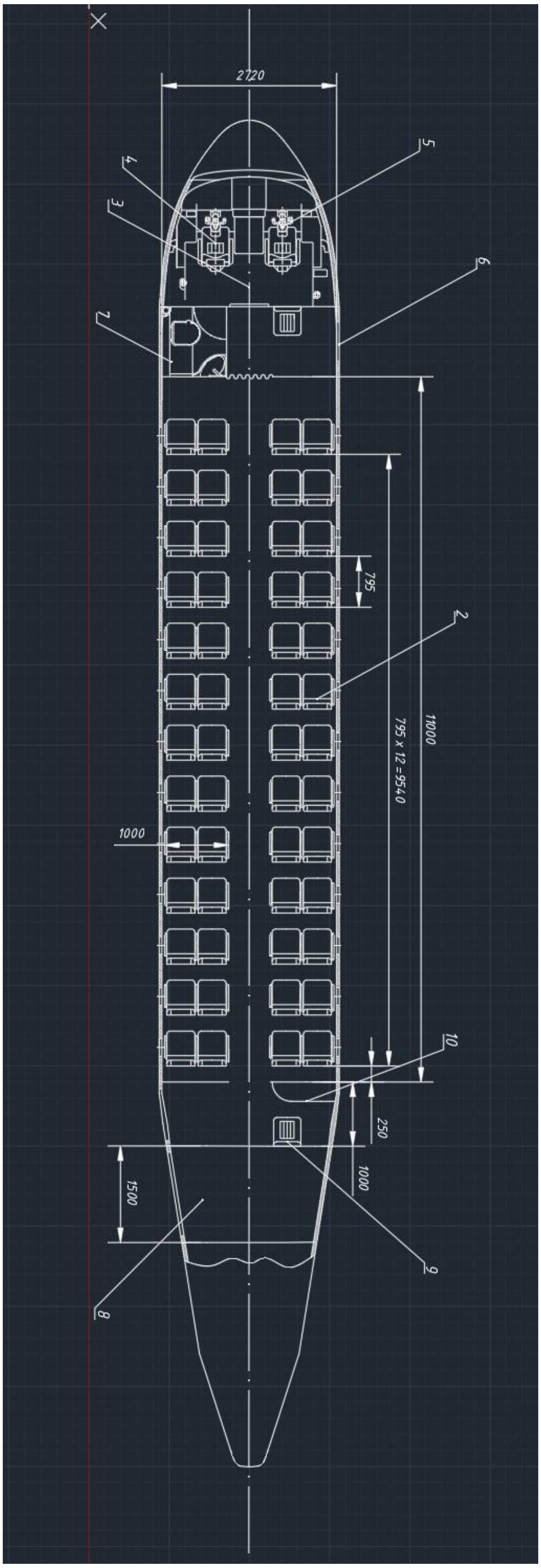


APPENDIX C

Scheme for the fuselage centering



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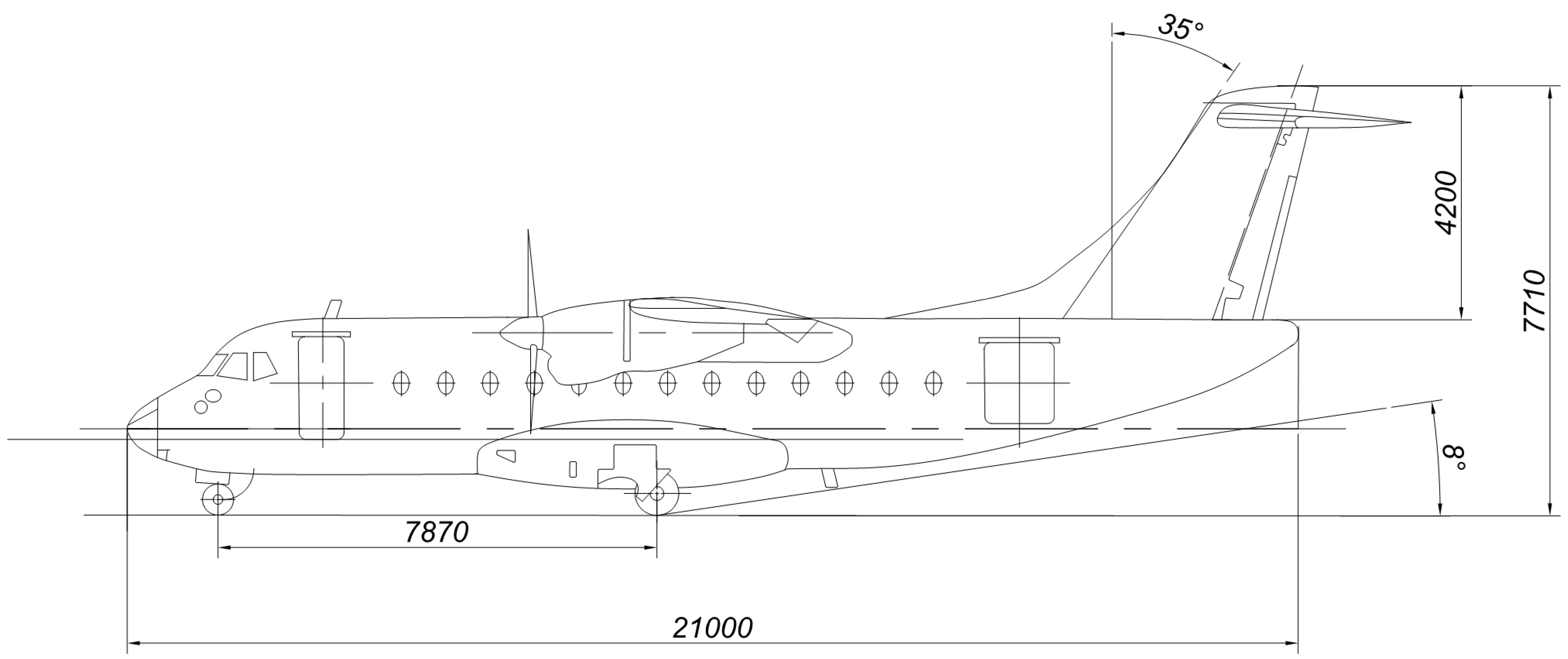
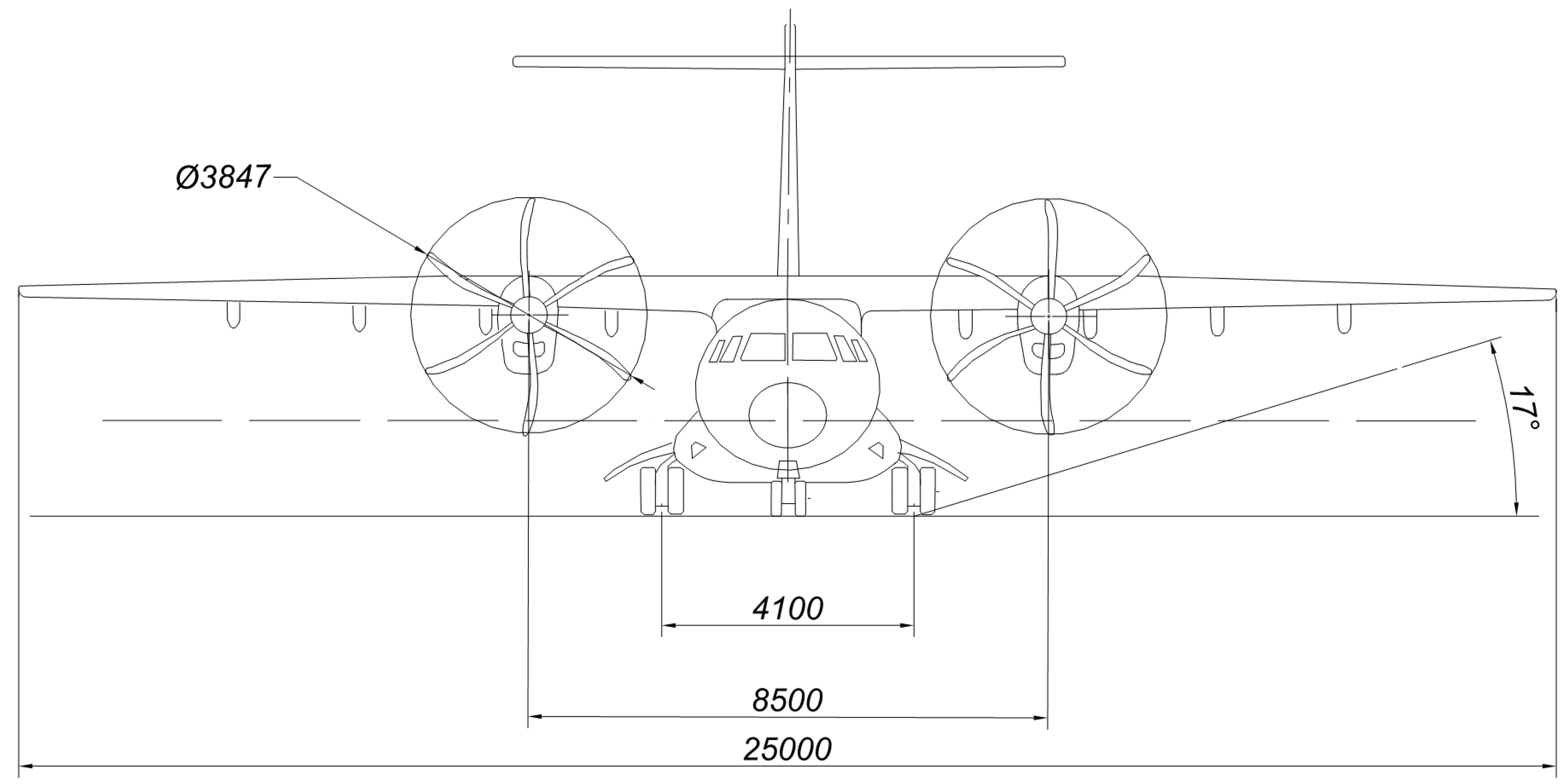
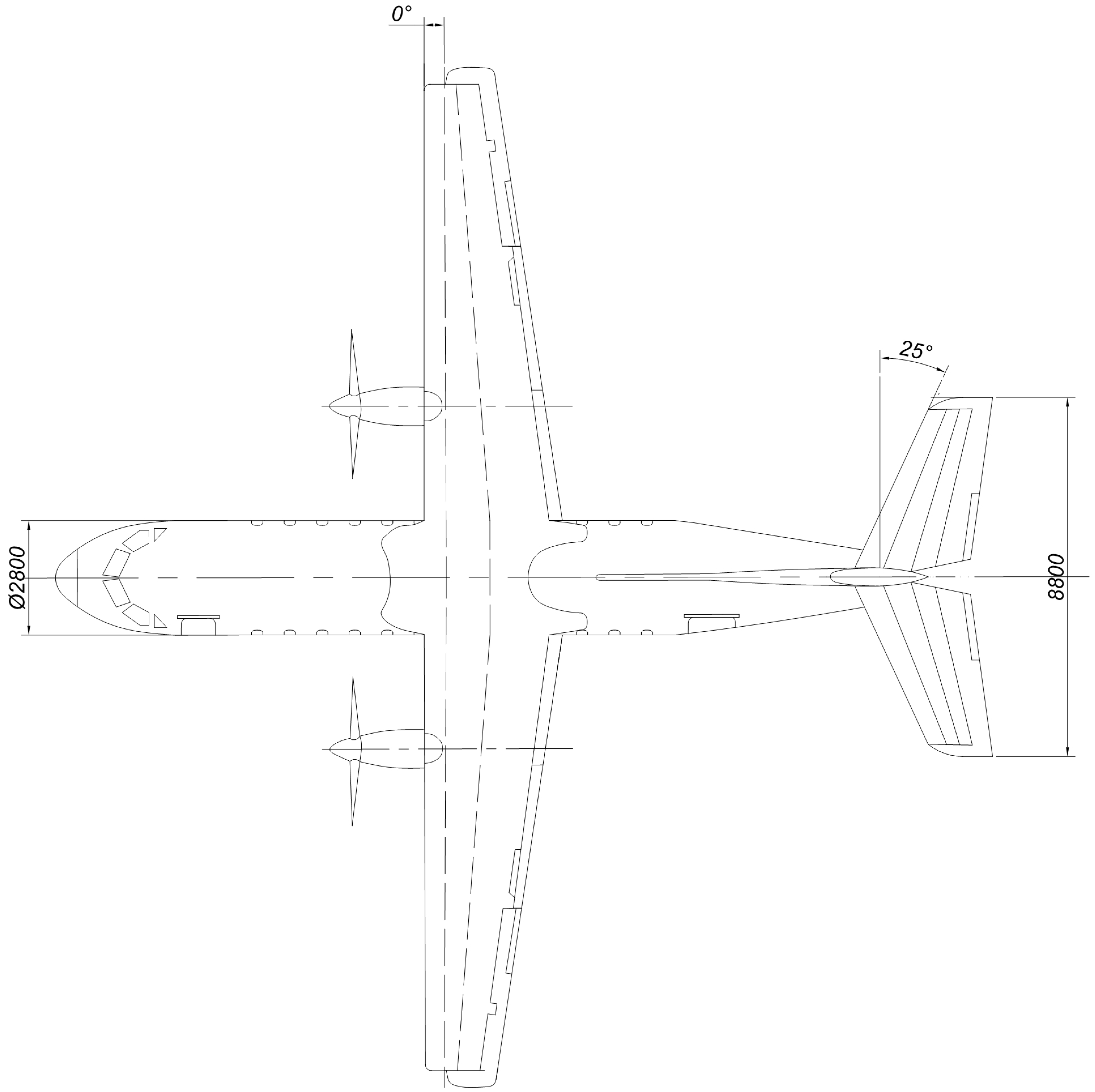


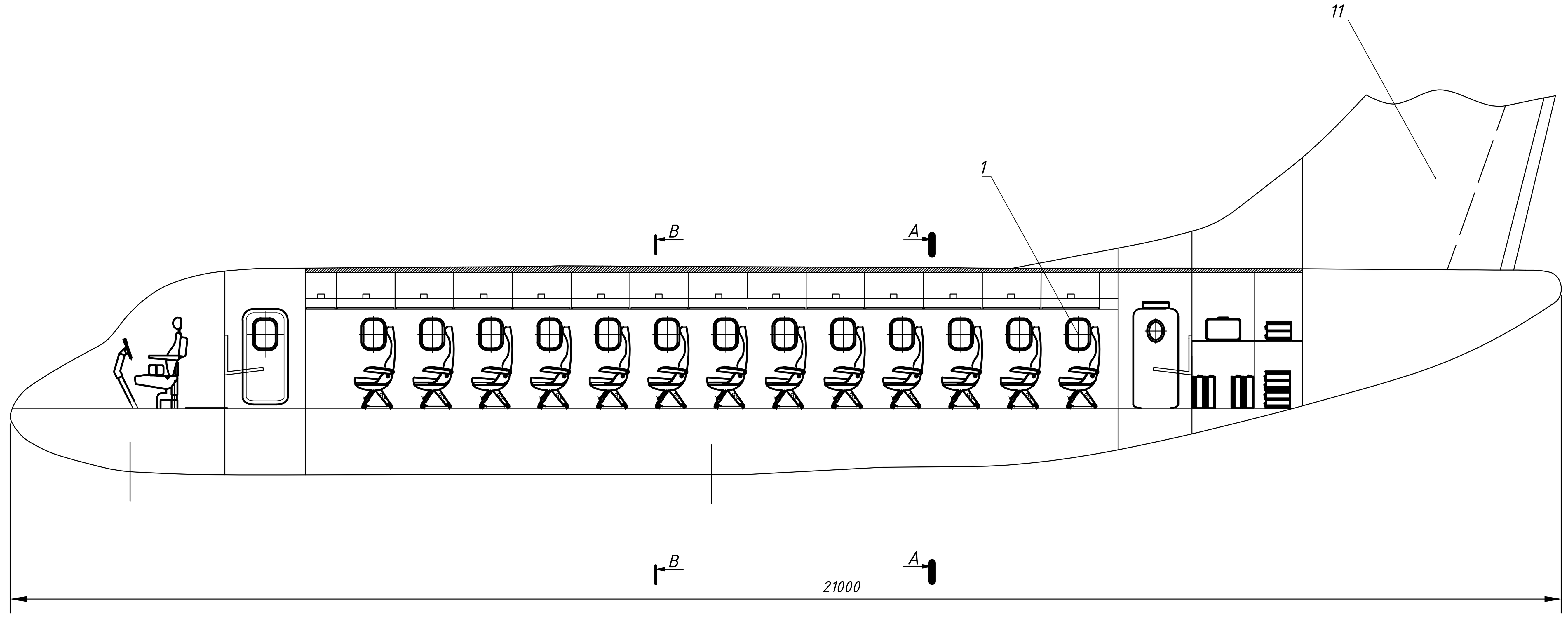


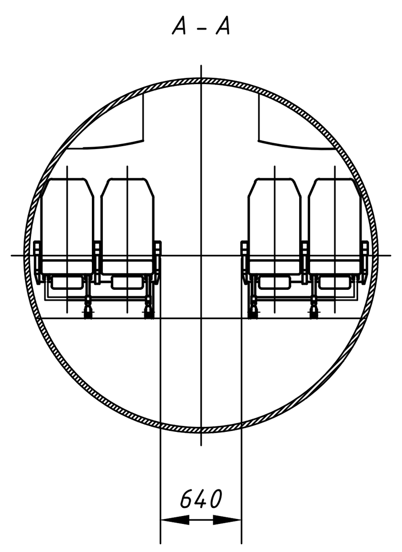


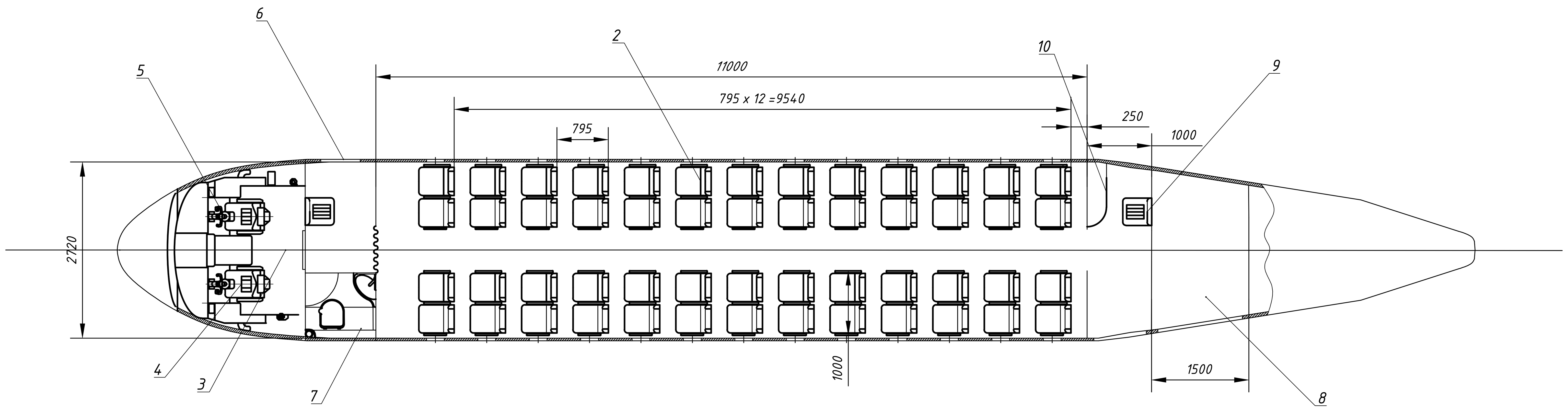
No	Main data	Abr.	Unit	Value
	Weights of the aircraft			
1	MTOW	m_0	kg	22 061
2	Payload	m_p	kg	5 148
3	Empty weight	m_{empty}	kg	11 700
	Geomertrical parameters			
1	Wing span	L	m	25
2	Wing area	A_{wing}	m^2	67.14
3	Length of fuselage	L_{wing}	m	21
4	Height	$H_{fuselage}$	m	7.71
5	Tip chord	b_{tip}	m	1.7
6	Root chord	b	m	3.6
7	Mean aerodynamic chord	b_{rot}	m	2.51
8	Aspect ratio	λ_{MAC}	-	9.5
9	Taper ratio	η	-	2.1
10	Quarter-chord sweep angle	$X_{1/4}$	°	0
	Flight performances			
1	Flight range	L	km	1300
2	Cruise speed	V	km/h	520
3	Takeoff speed	V	km/h	217
4	Takeoff distance	$L_{takeoff}$	m	1219
5	Landing speed	$V_{takeoff}$	m/s	202
6	Landing distance	$L_{landing}$	m	1088
	Power plant			
1	Number of engines	N	-	2
2	Thermo. Power	T	hp	2400
3	Mech. Power	M	hp	2100
4	Type of engine			Turboprop

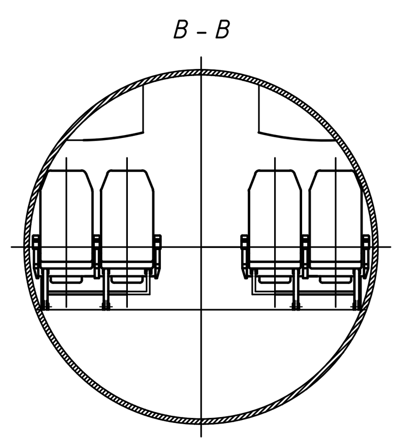
Aircraft Design Department					KAI 25 08 P 00 00 00 28 GV	
Ch.	Sheet	№ docum.	Sign.	Date	Short range passenger aircraft	Scale 1:75
Developed		Petrov V.V				Sheet 1 / Sheets 2
Checked		Yakobchuk.O.Y				
Reviewed		Krasnopolsky V.S			General view	Ба-134-21-1-ОС
Confirm		Maslak T.P.				

KAI 25.08P.00.00.00.28 FL





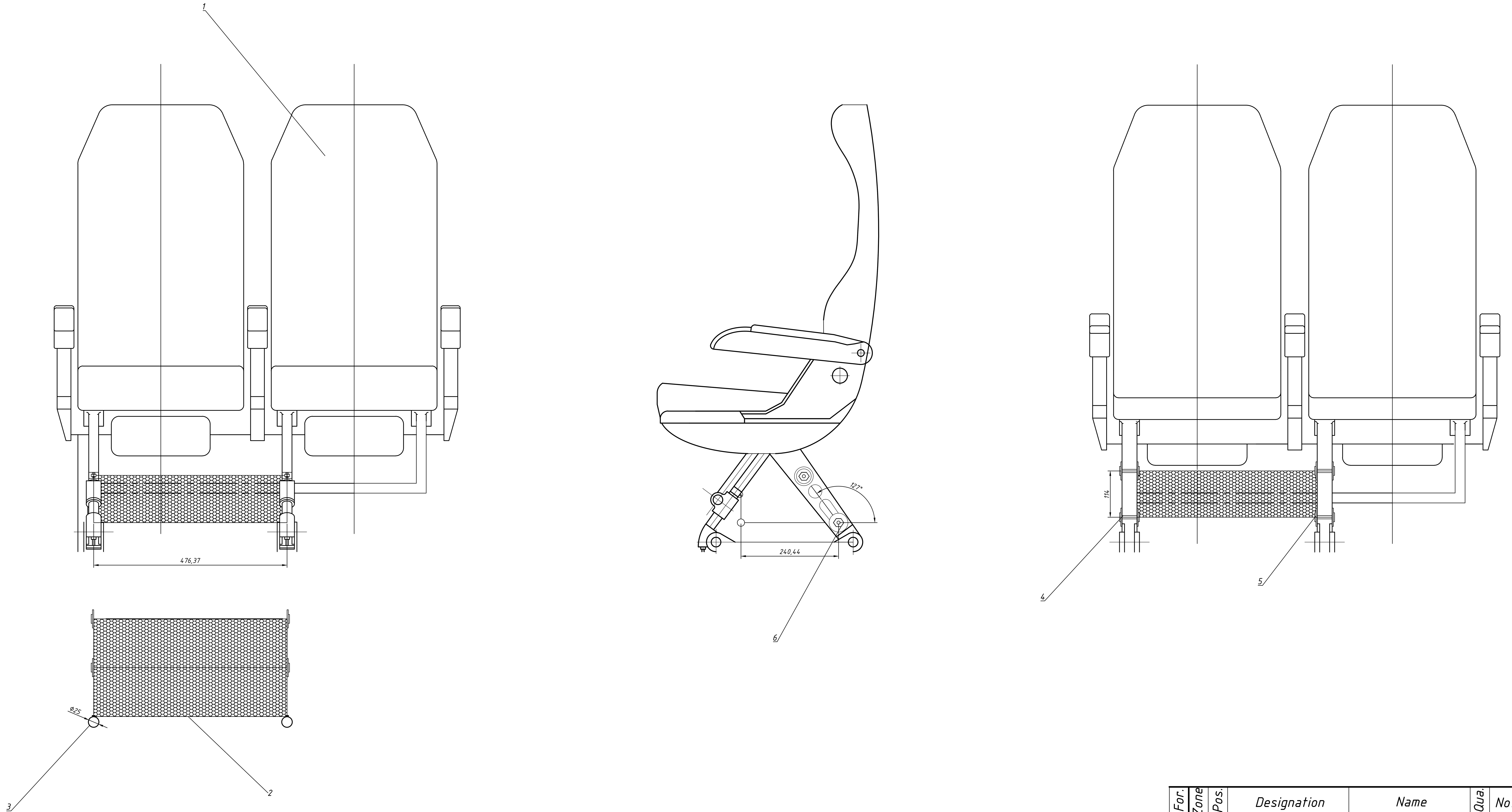




For.	Zone	Pos.	Designation	Name	Qua.	Note
		1	KAI 25 08P 00 56 20	Porthole	13	
		2	KAI 25 08P 00 25 10	Passenger seats	52	
		3	KAI 25 08P 00 25 20	Cockpit	1	
		4	KAI 25 08P 00 25 10	Pilot seat	2	
		5	KAI 25 08P 00 27 10	Control wheel	2	
		6	KAI 25 08P 00 52 20	Emergency exit	2	
		7	KAI 25 08P 00 25 40	Lavatory	1	
		8	KAI 25 08P 00 25 50	Luggage compart.	1	
		9	KAI 25 08P 00 25 10	Flight attend. seat	2	
		10	KAI 25 08P 00 25 30	Kitchen	1	
		11	KAI 25 08P 00 55 30	Vertical tail	1	

Aircraft design department					KAI 25.08P.00.00.00.28 FL			
Ch.	Sheet	№ document	Sign.	Data	Short-range passenger aircraft	Letter	Mass	Scale
Performed		Petrov V.V						1:100
Checked		Yakobchuk O.Y.				Sheet 1		Sheets 2
Reviewed		Krasnopolsky V.S.			Layout			
Approved		Maslak T.P.						

KAI 25.08P.00.00.00.28 AD



For.	Zone	Pos.	Designation	Name	Qua.	Note
		1	KAI 25 08P 00 25 10	Passenger seat	1	
		2	KAI 25 08P 00 25 00	Mesh	1	
		3	KAI 25 08P 00 25 00	Collar	2	
		4	KAI 25 08P 00 25 00	Bushing	4	
		5	KAI 25 08P 00 25 00	Nut	4	
		6	KAI 25 08P 00 61 00	Screw M6 x 16	2	
		6	KAI 25 08P 00 61 00	Screw M6 x 35	4	

Aircraft design department		KAI 25.08P.00.00.00.28 AD			
Ch.	Sheet	Nº document	Sign.	Data	
Performed		Petrov V.V			Short-range transport aircraft
Checked		Yakobchuk O.Y			Letter / Mass / Scale: 1:100
					Sheet 1 / Sheets 2
Reviewed		Krasnopolsky V.S			Mesh for additional baggage space
Approved		Maslak T.P.			