MINISTRY OF EDUCATION AND SCIENCE OF UKRAINE
NATIONAL AVIATION UNIVERSITY
DEPARTMENT OF AIRCRAFT DESIGN

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«____»___________2020

DIPLOMA WORK

ON SPECIALTY
"AVIATION AND SPACE ROCKET TECHNOLOGY"

Topic: «Baggage compartments design for animal's transportation»

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Aerospace Faculty

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«____»___________2020 year

TASK

for the master thesis

VOLOSHAN OLEKSANDR VALERIYOVICH

1. Topic: «**Baggage compartments design for animal's transportation**», approved by the Rector's order № 1906/ст from 5.10.2020 year.

Period of work execution: from 5.10.2020 year to 13.12.2020 year.

3. Initial data: cruise speed V_{cr}= 800 km/h, flight range L = 3500 km, operating altitude H_{op} = 12.2 km, crew members 2, payload 8.28 tons.

4. Content: analysis of problems during transportation of animals in the baggage compartments, methodology, preliminary design of an aircraft as an object of research, development of safe containers for transportation of animals in baggage compartments, analysis of hazardous and harmful production factors, calculation of oxide emissions and carbon monoxide emissions from aviation.

5. Required materials: general view of the airplane (A1×1); layout of the airplane (A1×1); general view of the animal's container (A1×1); 3D view of the container (A1×1). Graphical materials are performed in Auto Cad, Excel.

6. Thesis schedule:

№	Task	Time limits	Signature
1	Task receiving, processing of statistical data of prototypes	5.10.2020-10.10.2020	
2	Review of the requirements to the animals transportation	11.10.2020 – 15.10.2020	
3	Aircraft geometry calculation	16.10.2020 –18.10.2020	
4	Aircraft layout	19.10.2020 – 25.10.2020	
5	Aircraft centering determination	26.10.2020 – 1.11.2020	
6	Graphical design of the parts	02.11.2020 – 8.11.2020	
7	Execution of the scientific part of diploma	9.11.2020 – 13.11.2020	
8	Graphical design of the containers	14.11.2020 – 28.11.2020	
9	Completion of the explanation note	29.11.2020 – 5.12.2020	

7. Special chapter consultants:

Chapter	Consultants	Date, signature	
		Task Issued	Task Received
Labor protection	E.V. Konovalova		
Environmental protection	L.I. Pavlyuh		

8. Date: "______"_______________2020 year

Supervisor: _________________ **T. P. Maslak**

Student: _________________ **O. V. Voloshan**

ABSTRACT

Master degree thesis "Baggage compartments design for animal's transportation"

62 pages, 13 fig., 8 tables, 7 references

Object of study – is a process of transportation of animals in the baggage compartments during flight.

Subject of study –is the container for animals.

Aim of master thesis – is a development of container, which will support such parameters for vital functions of animal's as oxygen, water, food, comfort to minimize stress during flight.

Research and development methods – are to think out all possible necessities of animals and their behavior during different situations, find out opinions of animal's owners, improve the theoretical view and create a model in 2d and 3d programs.

Novelty of the results – it is the creation of a new type of containers for animals which will allow to transport animals in the baggage compartments.

Practical value – At first, such type of container will interest people by the ability to transport their animals where they want without necessity to flight with them in the cabin. And as the result, of using these containers, will disappear noise from animals, smells and problems. Which means that more comfortable flight both for owners and for another.

AIRCRAFT, PRELIMINARY DESIGN, LAYOUT, CENTER OF GRAVITY POSITION, DESIGN OF CONTAINER, 3D DESIGN OF CONTAINER

CONTENT

INTRODUCTION

The problem of this graduate work is to create containers for transporting animals in the baggage compartment of mid-range aircraft. To create safety containers with necessary standards not allow them to die and with bracing not allow these containers fall, roll over or hit.

Since air transport is the most humane way of transporting live animals on long journeys, it is important to ensure that all participants meet high standards: veterinary inspectors, animal handlers, handlers and maintenance personnel, container manufacturers, air carriers. , pilots, etc. are best achieved through regulation. and supervision.

Live animal regulations should strike a balance between ensuring compliance with aviation safety requirements and regulations and treating animals humanely in accordance with applicable welfare standards. The safety of crew members, passengers and animal operators must also be considered.

The International Air Transport Association (IATA) is not a regulatory body, but member airlines must enforce the IATA Live Animals Regulations (LAR). Thus, IATA LAR has become the global standard for the transport of live animals by commercial airlines and is referenced by supranational and national regulatory authorities. As well as providing guidance for airlines, the LAR is used by shippers, freight forwarders, and animal care professionals. The LAR contains a comprehensive classification of 1000's of animal species along with the container specifications required for their transport. It also includes information on handling, marking & labelling along with necessary documentation when transporting animals by air

Transporting animals on an airplane is stressful not only for the owners themselves (you need to issue several permits, a veterinary passport, get vaccinated, buy a seat and register the animal), but also the animals themselves. Each airline has its own rules for the transport of animals, which are usually detailed on their homepage.

Some European companies offer three options for transporting the animal: in the cabin, in the luggage compartment, and in the luggage compartment as cargo.

In 2018, US. airlines recorded a total of 17 deaths and 26 injured animals during transportation. For comparison, in 2011, 35 animals died during flights. In 2017, 18 pets did not transfer the flight on the flights of this particular carrier. At the same time, in 2018, the airline also transported a significant part of the animals, if we take into account 17 different carriers that make flights to the United States. The numbers for 2018 look like this: 138,178 out of 506,994 registered for flights of pets. This is a third of the dead animals. According to reports from the US Department of Transit, the cause of death for most animals is unambiguous. For most of them, oxygen deficiency or heart failure has become fatal. In 2018, 9 animals died on United Airlines flights, 5 on Delta flights, and 4 on American Airlines. Also, in 23 cases, animals were injured on United Airlines, and the statistics of such incidents is 2.1 per 10 thousand flights. In Hawaiian Airlines, this figure is worse – 3.9. There are many reasons why people wish to transport live animals. The animals may be personal pets, or guide and assistance dogs. They may be sporting animals, agricultural animals for breeding, food animals being transported for slaughter, zoological animals and species being transported for reasons of science. But in the baggage compartments at the bottom of the aircraft there are no conditions for the normal stay of the animal. Extremely low temperatures, lack of ventilation and lack of oxygen can affect it. In everyday life, animals can rarely be found in conditions close to flying in an airplane. During the flight, they feel pressure drops, hear extraneous sounds, feel shaking that they do not understand, caused by turbulence. All this causes an increased sense of anxiety. This primarily affects the cardiovascular system.

Unfortunately, Ukrainian airlines do not provide such statistics, however, as we found earlier, almost all airlines (both foreign and Ukrainian) have equivalent conditions for the transportation of animals, which allows us to conclude that the statistics of animal deaths on Russian airlines does not differ from foreign.

At the same time, animal welfare organizations strongly discourage transporting your pet in the cargo hold or as checked baggage, which is placed in the baggage compartments at the bottom of the aircraft. This is due to the fact that in these places there are no conditions for the normal stay of the animal. It can be affected by extremely cold temperatures, lack of ventilation and lack of oxygen. In everyday life, animals are rarely in conditions close to flying on an airplane. During the flight, they feel pressure drops, hear strange sounds, feel shocks they do not understand, caused by turbulence. All of this is more worrying. It mainly affects the cardiovascular system.

The safe transportation of live animals as air cargo is based on controlling three environmental factors:

- carbon dioxide concentrations;
- temperature;
- relative humidity levels.

Each type of animal has unique environmental requirements for optimum health. Failure to adequately control these environmental factors may have an impact on animal well-being, comfort, and survive-ability.

Combining the idea of creating conditions for the safe transport of animals with the technical achievements of our time, we can highlight some of the nuances of introducing such a perfect container for the transport of animals.

First, of course, you will need a material investment in the purchase of such cameras, boxes and related equipment (operating system, tablets, video cameras, etc.).

Second, staff training costs (administrators) are necessary to track the selected parameters of keeping animals in transportable condition on the recommended tablets and respond quickly according to the situation (temperature rise, water supply or foods).

PART 1. STATE OF THE ART LITERATURE REVIEW

1.1 Requirements and considerations to the animal’s transportation

All countries and all aviation companies have requirements and consideration on transporting animals. The general safety regulations help protect passengers, their pets or animals by guarding against the spread of diseases, and injury of people and animals. Of course, the certificate of veterinary inspection (CVI) is the main responsibility of animal’s owner to get this information from the authorities of your destination, but it is not the last requirements. In this part of the diploma work, I will analyze the requirements to the animal’s transportation from both size – from the side of animal’s owner and from the side of aviation company.

According to IATA LAR (Live Animals Regulations) there are several points for transporting animals:

- Design and construction;
- Container dimensions;
- Ventilation;
- Food and water;
- Container marking.

- Design and construction: when creating containers for animals, it is necessary that the animal has enough place to move. The container must be reliable, strong, withstand impacts, so as not to be damaged. For some species, reinforced containers are needed due to their weight and size. Must be free of toxic materials. The door must be such that the animal does not accidentally open it from the inside. The container must not cause pain or harm to the animal. Everything inside should be smooth and round. The container must be clean and airtight. If the container is to be used again, it must be cleaned and disinfected. Spread on absorbent mat. Containers for water and food should be appropriate for the size and type of animals. If the container has wheels, they must be removed or prevented from performing their function.

- Container dimensions. The size of the containers must match the actual size of the animals. The animal must be able to stand up, turn and lie down naturally.

- Ventilation. Ventilation must be on at least three sides. Ventilation openings should prevent the animal from escaping from the container.
- Food and water. There should be separate feeders for water and food, fixed inside. Have round edges and be free from toxic materials. Instructions on how to feed and drink must be attached to the container, and copies to accompany shipping documents. Register any water or feed and indicate the date and time of delivery on the container.
- Container marketing. The container must be properly labeled in accordance with the instructions. Labels should not obstruct ventilation openings, especially on small containers.

On the UIA website (Ukraine International Airlines) we also can see the general rules for the transportation of animals: UIA only carries dogs and cats, transportation of animals is possible only if accompanied by an adult passenger, UIA is not responsible in case of refusal, import or transit of animals, service animals are transported without limitation in size and weight, namely guide dogs and help dogs of government officials.

Some companies cat takes on board the animals as luggage: animals must be clean and healthy; a container (cage) is used to transport animals: dimensions that make it possible to stand, turn freely and lie; clean and protected from leaking, escaping and scratching; provides adequate ventilation; convenient for transportation, feeding, cleaning. It is allowed to carry a maximum of 2 animals of the same species in one container of similar size. The total weight of the container must not exceed 75 kg.

The main requirements for containers are:

- It is forbidden to carry in containers made by yourself
- Be clean and in working order
- Ventilation from at least 3 sides
- Labeled
- Have handles along the two long sides, in the middle.
- Have no toxic materials
- Do not harm animals
- The bottom of the structure must be solid and waterproof.

1.2 The main difficulties of transporting animals

Supervision and control. Usually people and organizations and airlines must first obtain a permit before they can transport animals. Such permissions are limited in time. The staff must be properly trained and perform their duties. The personnel consist of: ground personnel, the aircraft commander, the captain of the loader and the free crew and the orderly. It is necessary to demonstrate competence and, in the event of failure, re-certification. To control the transport of animals, certificates, declarations, poured logs, and container labeling are required.

For air transportation of different pets requires careful preparation:

- confirm the absence of infectious diseases;
- prepare food and drink;
- prepare the aircraft luggage compartment for this type of animal;
- prepare special containers and other means of fixing animals.

Key Factors that affect the safe transport of live animals include the:

- Aircraft Environmental Control System settings;
- animal physiology;
- airport and en-route environments;
- ground handling.

The main difficulties of transporting animals

1. The container with the animal is unloaded into the same compartment where other cargoes are stored. Of course, no specialized pet department is provided. This means that the animal will stand in a row of other boxes, perhaps the boxes will be on top of its container or under it.

2. Baggage is not pinned. This means that in the turbulence zone, containers move, fall, stand at an angle and knock against each other. You can only imagine what is happening in the head of the animal at that moment.

3. There is no sound insulation. Why isolate from a noise a compartment in which people are not in flight? This is an extra waste of money, effort, time and other resources. That is, the noise that is created during takeoff, flight and landing is clearly heard in the luggage room. For a person, such a noise is stress, even if he realizes that it is just an

engine, but what an animal that does not even understand what is happening to him, where it is and why he was left here.

4. The luggage compartment is not basic, and it does not have a backup computer. If one system fails, then in flight it will not be replaced. Of course, technical details will not fly, but the heating mode can easily go astray. If in normal mode the compartment maintains a temperature approximately equal to the cabin, then when it is turned off, it drops from about -40 to -50 degrees. At the same time, animals have practically no chance to survive.

Conclusion to the part

So, based on all of the above, I highlighted some aspects of creating a model of a box-container that can safely transport animals, with maximum safety and minimum risks:

1. The ability to control temperature (in this aspect, we can use sensors that are configured according to the type of temperature measurement, which provide information to the main service computer of the air carrier and the tablet of the cabin).

2. The ability to supply water (or food on long-haul flights), in particular, by creating a drinking bowl that delivers water in automatic mode (for simplicity, we can configure it by the type of alarm), or using a command from a service computer and tablet on the cabin)

3. The ability to track the condition of animals using a video camera that feeds the image to a tablet located in the cabin.

4. Sound insulation of the container, while technically this condition turned out to be the most difficult, but solvable. For this, it is necessary to create a soundproofing chamber, presented in the form of a block with a suspended structure and ventilation structures (for air inflow and outflow). Floating floor - for protection against structural noise, thermal insulation inside the “prechamber” to prevent condensation from the side of the ventilation chamber. It can be any with a thickness of insulation according to calculation. Sound insulation from inside the ventilation chamber is possible to prevent the spread of airborne noise. In this chamber several boxes of containers for animals’ can be located. The camera should be illuminated with soft light, and equipped with sensors for measuring the level of oxygen.

In my opinion, specially designed chambers and containers for transporting goods will not only increase the safety of animal transportation, but also transport them using various products that cannot be transported in another form. This means that their cost is not always high. These cameras can be used to transport drugs and presented in this article requires careful development and testing of the created device, however, these solutions are based on already existing technologies that do not require special time and material costs, which allows us to simplify the process of creating ideal container containers for transportation in flight.

PART 2. PRELIMINARY DESIGN OF SHORT-RANGE PASSENGER AIRCRAFT

2.1 The object of the investigation – short range passenger aircraft

The subject of my graduate was the aircraft preliminary design for short and medium flights to transport 80 passengers and baggage with modification of the luggage compartment for the possibility to install the container for animal's transportation.

Prototypes of the aircraft, taking for the designing aircraft were in class 70-100 passengers. Such aircraft like AN-148, Bae 146 and ТУ-334 will compete with projected aircraft in this market segment. Statistic data of prototypes are presented in table 1.1.

Table 1.1 – Operational-technical data of prototypes

Name and dimensionality	AN-148	Bae 146	ТУ-334
Purpose	Passenger	Passenger	Passenger
Max payload	9000 kg	11000	11500
Crew, [persons]	4	4	3
Passengers	70	90	102
Range of cruising altitudes, [km]	12.2	11.5	11.5
$V_{cr\ max}$ / H, [km/h / km]	800	900	850
$V_{cr,econ}$ / H, [km/h / km]	650	750	800
Thrust/weight ratio kN/kg	3.23	2.94	3.069
Number of engines and their type	2xturbojets Д-436-148	4× Lycoming AL 502R-5	2× turbojets Д-436Т1
Take-off thrust, [kN]	63	128	147
Pressure ratio	35	29	33
Take off run distance, [m]	1800	2000	1900
Landing run distance, [m]	1000	1200	1000
Wing span, [m]	28.91	26.34	29.77
Sweepback angle at ¼ of	29	14	24
Fuselage length, [m]	29.13	28.6	28.05
Fuselage diameter, [m]	3.5	3.5	2.9
Vertical tail height, [m]	8.19	8.61	9.39
Vertical tail span, [m]	9.1	8.67	11.12

Successfully chosen scheme allows increasing the safety and regularity of flights, as well as the economic efficiency of the aircraft.

The designed aircraft is a high-profile monoplane with bypass turbojet engines located under the wing and a tricycle landing gear. The fuselage has a circular cross section. Empennage has a T-shaped design, with an adjustable vertical stabilizer mounted on the edge. The rudder and elevators are equipped with aerodynamic balance.

The fuselage, rationally combining the advantages of form and elongation of parts, has the lowest possible resistance and a high critical value of M. The cabin has space for the first and second pilots.

There are windows on the left and right sides of the cabin, and there are emergency exits on the left and right sides. Luggage racks are installed along the cabin on both sides to accommodate passengers' personal belongings. Service panels with individual ventilation injectors, lights, buttons for the inclusion of individual lighting, flight attendant call button and seat light numbering. The ceiling of the general interior lighting is located in the central part of the ceiling: in addition, there are side lights and the lower part of the luggage compartment.

The following compartments are located under the floor of the fuselage: the nose gear wheel well, the front cargo compartment, the rear cargo compartment, the technical compartment. The front and rear cargo compartments are airtight, each has a hatch on the right side and is equipped with a container lock system.

Swept wing has the torsion box structure. Ailerons and aerodynamic balances are installed. The leading edge of the wing is equipped with air-thermal and electro thermal anti-icing device. Warm air in the nose of the central wing is supplied from the compressors of aircraft engines.

T-type tail unit consists of vertical and horizontal tail. Vertical tail includes fin and rudder, horizontal tail - stabilizer and elevators. Before the fin, the dorsal fin is attached to the fuselage.

The configuration of the workplaces of the pilots provides any of them control of the safety of the aircraft. The stability and controllability characteristics of the aircraft, the structure, characteristics and automation of onboard navigation equipment and on-board systems, the structure and configuration of the display equipment ensure that pilots perform their duties without exceeding the existing load standards.

The use of conical windshields at random from the cockpit provides good visibility for pilots and meets flight requirements in expected conditions. There is the possibility of manual and automatic control from anywhere in the pilots.

The upper control panel of the onboard systems contains the fuel, hydraulic, power supply, anti-icing system, air conditioners, engine and APU starting, fire extinguishing switches and alarm panel.

The aircraft control system includes: the elevator control system, stabilizers, rudder, ailerons and spoilers, air brakes, flaps and slats.

The landing gear is a support system that provides the necessary position of the aircraft during parking and its movement during take-off, landing and taxiing at the airfield.

On this plane, the landing gear is made according to the scheme with three bearings and relegated back by plane. This scheme allows you to get a steady movement of the aircraft through the airfield, effective maneuverability, through the use of control of the rotation of the wheels of the front legs, the horizontal position during immobility and movement. The chassis with a nose wheel allows you to take off and land with a strong side wind, as well as with straight motion while running and takeoff.

The front or nose support (strut) is located in front of the center of gravity, which avoids overturning “on the nose” and ensures effective braking of the wheels to reduce the run.

The main supports (struts) are located behind the center of gravity of the aircraft. They are in the released position recline, varying depending on the degree of compression of the shock absorbers.

The main legs of the chassis have a hydraulic brake system for the wheels and devices that automatically adjust the braking force of the wheels, which eliminates the appearance of a skid.

Power plant: engine D-436T2. The low pressure compressor is driven by a four-stage low-pressure turbine, and the high-pressure compressor is powered by a two-stage high-pressure turbine. The high-pressure turbine also drives the gearbox, which, in turn, drives the engine and auxiliary equipment installed on the aircraft. The control system controls all engine functions, including power management. The role of the pylon on each side of the fuselage:

- support the engine;
- transfer load to the back of the fuselage;

2.2 Geometry calculations for the main parts of the aircraft

The layout of the aircraft consists of 8, making up the relative location of its parts and structures, 5 and all types of cargo (passengers, cargo, fuel, baggage, etc.).

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

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

Relative wing extensions area is 0.1

Wing area is: $S_w = 125,04 * 0,9 = 112,536(m^2)$;

According to my prototype An-148, I decided to reduce wing area to:

$S_w = 95.67m^2$

Wing span is:;

Root chord is: ;

Tip chord is:

Maximum wing width is determined in the forehead i-section and by its span it is equal: $c_i = c_w * b_t = 0,14 * 1,763 = 0.247(m)$;

On board chord for trapezoidal shaped wing is:

I use the geometrical method of mean aerodynamic chord determination (figure 2.1). Mean aerodynamic chord is equal: $b_{MAC} = 3,49m.$

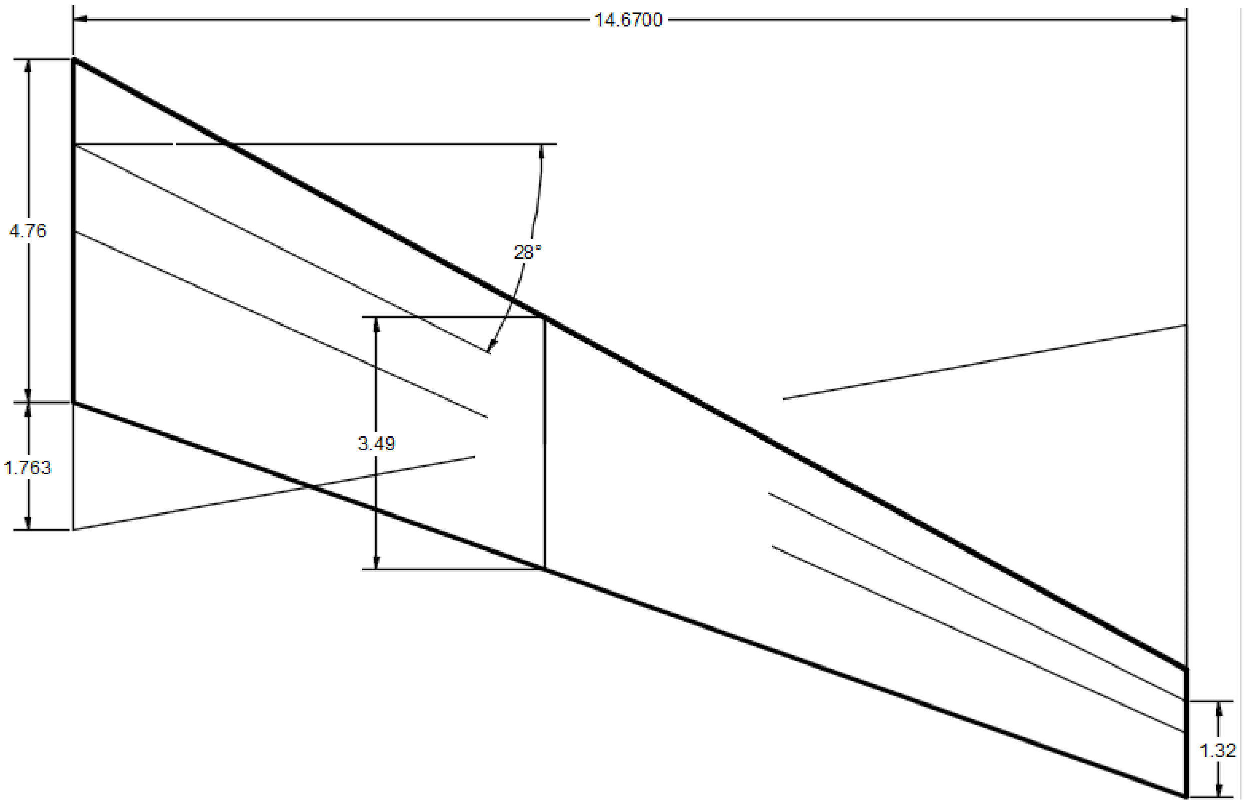

Figure 2.1 – Determination of mean aerodynamic chord

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_{ail} = 0,375 * (l_w/2) = 5,5(m);

Aileron area: S_{ail} = 0,065*S_w/2 = 3,12(m^2);

Aerodynamic compensation of the aileron.

Axial $S_{axinail} \leq$ (0,25…0,28) S_{ail} = 0,26*3,12 = 0,81(m^2);

Inner axial compensation $S_{inaxinail}$ = (0.3...0.31) S_{ail} = 0,967(m^2);

The area of the trimmers of the Aileron is for airplanes:

- with two engines: $S_{tr.ail}$ = (0,04…0,06) *$S_{ail.}$ = 0,05 * 3,12 = 0,156

Range of aileron deflection

Upward $\delta'_{ail} \geq 25^\circ$;

Downward $\delta''_{ail} \geq 15^\circ$.

Fuselage layout

For transonic airplanes fuselage nose part has to be:

l_{fnp} = 2,1 * D_f = 2,1 * 3,5 = 6,5 (m);

To geometrical parameters we concern: fuselage diameter D_f; fuselage length l_f; fuselage aspect ratio λ_f; fuselage nose part aspect ratio λ_{np}; tail unit aspect ratio λ_{tu}. Fuselage length is determined6considering the aircraft scheme, layout7and airplane center-of-gravity1position peculiarities, and the conditions of landing angle of attack α_{land} ensuring. 2235

Fuselage length is equal: L_f = FR * D_f = 8,3 * 3,5 = 29,6(m);

Fuselage nose part aspect ratio is equal:

Length of the fuselage rear part is equal: $l_{frp} = \lambda_{frp} * D_f$ = 3 * 3,5 = 10,5(m);

For short range airplanes we may take the height as: h_1=1.75m; passage width b_p=0.45...0.5m; the distance from the window to the flour h_2=1m; luggage space h_3=0.6...0.9m.

For long range airplanes correspondingly: h1 = 1.9…2.1 m; the distance from the window to the flour h2 = 1 m; luggage space h3 = 0.9 ... 1.4 m, passage width b_p=0.6m.

I choose the next parameters:

Cabin height: h_1=2.1m

Window to floor distance: h_2=1m.

The windows are placed in one light row. The shape of the window is round, with the diameter of 400mm, or rectangular with the rounded corners.

For economic salon with the scheme of allocation of seats in the one row

(3 + 2) determine the appropriate width of the cabin

$H_{cab} = 1.48+0.17B_{cab}$ = 1.48+0.17*3.15 = 2.016(m)

$B_{cab} = n_{3chblock} * b_{3chblock} + n_{2chblock} * b_{2chblock} + b_{aisle} + 2\delta$ =

=1500+1000+500+2*100=3.2(m)

$L_{cab} = L_1 + (n_{raws} - 1) * L_{seatpitch} + L_2$ = 1200 + (14-1) * 762+250 = 12.56(m)

Luggage compartment

Given the fact that the unit of load on floor K = 400… 600 kg/m^2

The area of cargo compartment is defined:

Cargo compartment volume is equal:

$V_{cargo}=v*n_{pass}$ = 0.2 * 70 = 14(m^3).

Galleys and buffets

Volume of buffets(galleys) is equal:

V_{galley} = 0.1 * 70 = 7 (m^3).

Area of buffets(galleys) is equal:

$S_{galley} = V_{galley}/H_{cab}$ = 8/2.016 = 3.968(m^2).

Lavatories

Number of toilet facilities is determined by the number5of passengers and flight duration: with t> 4:00 one7toilet for 40 passengers, at t = 2 ... 4 hours and 50 passengers

t <2 hours to 60 passengers.

The number of lavatories I choose according to the original airplane and it is equal: n_{lav}=2. ……..

At the time of the flight is less than 1 hour and number of passengers to 15, the toilets do not. With a large number of toilets for increased throughput ability toilet separated from the sink. A toilet area Stual = 1,5 ... 1,6 m^2 with a width of not less than one meter.

Area of lavatory:

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

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

Layout and calculation of basic parameters of tail unit

One of the most important tasks of aerodynamics is the choice of placement of the tail section. To ensure longitudinal stability8 during an overload, its center of gravity must be located in front of the focus of the aircraft, and the distance between these points, associated with the average value of the wing / aerodynamic belt, determines the longitudinal stability indicator.

Choose the area of aerodynamic balance.

$M \geq 0.75$

$S_{eb} \approx S_{rb} = (0,18 \ldots 0,23) * S$

In order to prevent the overcompensation of the rudder, it is necessary that

$S_{eb}/S_{el} = S_{rb}/S_{rud} \leq 0.3$.

Elevator balance area is equal:

Rudder balance area is equal:

The area of altitude elevator trim tab:

$S_{te} = 0.09 * S_{el} = 0.72(m^2)$

Area of rudder trim tab is equal:

$S_{tr} = 0.05 * S_{rud} = 0.366(m^2)$

Length and height of tail unit are equal:

$l_{tu}=(0.32 \ldots 0.5)*l_w = 0.34*29.34 = 9.9956(m)$

$h_{tu} = (0.12 \ldots 0.2) * l_w = 0.2 * 29.34 = 4.95(m)$

Landing gear design

In a primary stage of design, when the airplane center of gravity position is defined and there is no drawing of plane general view, only the part of landing gear parameters can be determined.

Main wheel axel offset is: $e = 0.2315 * b_{MAC} = 0.16 * 3.49 = 0.558(m)$

Landing gear wheel base comes from the expression

$B = (0,3...0,4) L_{ф} = (6...10)e$ $=0.344*29.05 = 9.99(m)$

Front wheel axial offset will be equal:

$d_{ng} = B - e = 9.99 - 0.558 = 9,435(m)$

Wheel track is: $T = 0.372*B = 0.372*9.99 = 3.715(m)$

On a condition7of the prevention of the side nose over the value K should be > 2H, where H – the distance from runway to the center of gravity.

- for high-planes (when locating engines on the wing) с.м. is located above the horizontal construction of the fuselage at a distance $Y_{ц.м.} = (0,08...0,10) D_{ф}$

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.

The load on the wheel is determined:

K_g = 1.5...2.0 – dynamics coefficient.

Choice and description of power plant

D-436T1, D-436T2, D-436TP - a family of aircraft gas turbine engines. There are a three-shaft high by-pass turbofan engine developed by the Ukrainian company. Designed for passenger and transport aircraft of short and medium range of flight (among them, the Tu-334(D-436T1), Tu-334-200 (D-436T2), Be-200(D-436TP)).

Table 2.2 – Examples of application Д-30КУ(КП)

Model	Thrust	Overall dimensions, mm	Dry weight
D-436T1	7500	3829×1802×1949	1450 kg
D-436T2	8400	3829×1802×1949	1520
D-436TP	7500	3729×1812×1929	1450

2.3 Determination of the aircraft center of gravity position

The curb weight of the wing contains the mass of its structure, the mass of the equipment placed in the wing and the mass of fuel. Regardless of the installation location (on the wing or on the fuselage), the main chassis and the forward gear are included in the mass register of the equipped wing. The mass register includes the names of the objects, the masses themselves and the coordinates of their center of gravity. The origin of the given coordinates of the centers of mass is chosen by the projection of the point of the top of the middle aerodynamic chord (MAC) for the XOY surface.

Positive values of the coordinates of the centers of mass are taken as the end part of the aircraft.

An example of a list of mass objects for an aircraft, where the engines are located under the wing, included the names given in Table 2.3.

An example of a list of mass objects for the aircraft, where the engines are located in the wing, included the names given in table 2.3. The mass of the AU is 44278 kg.

The coordinates of the center of force for the equipped wing are determined by the formulas:

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

Table 2.3 - Trim sheet of equipped wing masses

N	Name	Mass		C.G. coordinates	Moment (kgm)
		Units	total (kg)		
1	Wing (structure)	0,12169	5288,18982	1,396	7382,312989
2	Fuel system, 40%	0,067	2966,626	1,4658	4348,480391
3	Control system, 30%	0,00219	96,96882	1,047	101,5263545
4	Electrical equip. 30%	0,00337	149,21686	0,349	52,07668414
5	Anti-icing system 70%	0,01075	475,9885	0,349	166,1199865
6	Hydraulic system, 70%	0,001337	59,199686	2,094	123,9641425
7	Power units	0,067	2966,626	1,396	4141,409896
	Equiped wing(without l.g. and fuel)	0,19088	8451,78464	1,93046689	16315,89044
8	Nose landing gear	0,007	309,946	-7,906	-2450,433076
9	Main landing gear	0,0397	1757,8366	2,094	3680,90984
10	Fuel	0,2337	10347,7686	1,5007	15528,89634
	Equiped wing	0,53828	20867,33584	1,5850257	33075,26355

Origin of the coordinates is chosen in the projection of the nose of the fuselage on the horizontal axis. For the axis X the construction part of the fuselage is given. The example list of the objects for the AC, which engines are mounted under the wing, is given in table 2.4.

The CG coordinates of the FEF are determined by formulas:

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

We can find fuselage center of gravity coordinate **X_f** by divided sum of mass moment of the fuselage ($m_i^'$, X_i) on sum of total mass of fuselage ($m_i^'$):

$$X_f = \sum m_i \bullet X_i / \sum m_i$$

Table 2.4 – Trim sheet of equipped fuselage masses

N	Objects	Mass		Coordinates of C.G.	
		Units	Total (kg)		Moment (kgm)
1	Fuselage	0,10925	4837,3715	14,125	68327,87244
2	Horizontal tail unit	0,02743	1214,54554	27,25	29878,18287
3	Vertical tail unit	0,02905	1286,2759	26,343	28017,67573
4	Radar equipment	0,0035	154,973	2,1	325,4433
5	Instrument panel	0,006	265,668	5,03	1336,31004
6	Air-navigation system	0,0052	230,2456	3,05	702,24908
7	Radio equipment	0,0026	115,1228	2,6	299,31928
8	Toilet 1	0,00108	47,82024	18,75	10460,6775
9	Toilet 2	0,00108	47,82024	18,75	10460,6775
10	Buffet 1	0,00162	71,73036	17	394,51698
11	Buffet 2	0,00162	71,73036	17	394,51698
12	Control system, 70%	0,00511	226,26058	13,525	3060,174345
13	Electrical equipment, 7	0,03033	1342,95174	13,525	18163,42228

Continuation of the table 2.4

14	Hydraulic system, 30%	0,00573	253,71294	19,335	4905,539695
15	Air conditioning system equipment,20%	0,0053	234,6734	13,525	3173,957735
16	Heat and sound isolation	0,0092	407,3576	13,525	5509,51154
17	Anti-icing system, 30%	0,00745	329,8711	21,24	7006,462164
18	Seats of pass. economical class	0,0148	655,3144	17,579	11520,25861
19	Seats of crew	0,00068	30,10904	2,89	87,0151256
20	Seat of attendants	0,00027	11,95506	4,95	59,177547
21	Equipped fuselage without payload	0,2673	11835,5094	12,86	163518,9127
22	Passengers of economical class	0,1455	6442,449	16,25	104689,7963
23	Food	0,0018	79,7004	17,1652	1002,9748679
24	Baggage of passenger	0,029	1284,062	15,481	19879,62703
25	Cargo	0,0077	340,9406	18	6136,9308
26	Crew	0,00359	158,95802	3,2	508,665664
27	Attendants	0,0037	163,8286	4,2	688,08012
28	Non-typical equipment	0,0018	79,7004	15	1195,506
29	Total	0,46039	20385,14842	14,55	296949,4935

The list of mass objects for center of gravity variant calculation given in Table 2.5 and Center of gravity calculation options given in table 2.6, completes on the base of both previous tables.

Table 2.5 – Calculation of C.G. positioning variants

Name of object	Mass, kg m_i	Coordinates C.G. M	Moment kgm
Equipped wing without fuel and L.G.	8751,785	14,09865688	119158,8
Nose landing gear (retracted)	409,946	5,262189989	1630,995
Main landing gear (retracted)	1857,8366	15,26218999	26828,44
Fuel	10547,7686	13,66888999	141442,5
Equipped fuselage	12135,51	12,86	152204,7
Passengers of economical class	6642,449	16,25	104689,8
Food	79,7004	4,16528484	331,9749
Baggage of passenger	1384,062	9,481828	12175,26
Cargo	340,9406	17	5795,99
Crew	158,95802	3,2	508,6657
Attendants 1	163,8286	4,2	688,0801
Nose landing gear (opened)	409,946	4,262189989	1321,049
Main landing gear (opened)	1857,8366	14,26218999	25070,6
Reverse fuel	1610,83364	1,525	2456,521

Table 2.6 – Airplanes C.G. position variants

№	Name of objects	Mass, kg	Moment, kgm	C.G. m	Centering
1	Take-off mass (L.G. opened)	42472,78	565455,17	13,31	32,81
2	Take-off mass (L.G. retracted)	42472,78	563387,38	13,26	31,42
3	Landing variant (L.G. opened)	38792,91	518646,64	13,37	34,43
4	Transportation variant (without payload)	34025,63	440394,37	12,94	22,20
5	Parking variant (without fuel)	23155,08	299822,89	12,95	22,36

Conclusion to the part

In this part, I have prepared an analysis of prototype aircraft, made a selection of the main characteristics of the aircraft structure, a brief description of all parts of the aircraft. Made a selection of engines that meet the requirements for the projected aircraft, determined the geometric and design parameters of the fuselage layout.

Also I prepared an analysis of prototype aircraft, made a selection of the main characteristics of the aircraft structure, a brief description of all parts of the aircraft. I also made a selection of engines that meet the requirements for the projected aircraft, determined the geometric and design parameters of the fuselage layout.

The determined characteristics of the position of the center of mass are calculated. The basic calculations of the aircraft were shown. We checked the mass position of the main parts of the aircraft and the main equipment and equipment by its distance from the main aerodynamic belt. After designing the wing and fuselage, calculations were made to determine the center of gravity of the equipped aircraft.

PART 3. CONCEPTUAL DESIGN OF THE CONTAINERS FOR ANIMAL'S

3.1 Aspects of a box-container design capable of safely transporting animals

As discussed above, the main factors for my container include:

1. Ability to control the temperature;

2. Ability to supply water and food, and oxygen, in particular, creating a drinker that supplies water automatically;

3. Ability to monitor the condition of animals with a video camera that displays images on a tablet located in the cabin.

4. Soundproofing of the container. Both airborne noise and impact noise. To do this, I need to create a soundproof chamber, presented in the form of a block with a suspended structure and ventilation structures (for the inflow and outflow of air). Floating floor – to protect against structural noise, thermal insulation inside the "pre - chamber" to prevent the formation of condensation on the side of the ventilation chamber. It can be any with a thickness of insulation according to the calculation. Sound insulation on the inside of the ventilation chamber prevents the spread of airborne noise. This chamber can contain several containers for animals. The camera should be illuminated with soft light and equipped with oxygen level sensors.

5. Animals weighing more than 8 kg must be transported in the luggage compartment in special containers. The container must be made of durable impact-resistant material. The bottom of the tank is waterproof and absorbs moisture. It is necessary to ensure a secure closure so that the animal is not released. Also, the size of the container should allow the animal to stand upright and turn.

3.2 Development of container design

3.2.1 Dimensions

Pet containers can be located in the forward or rear underground baggage compartments. Since the noise from the engines is lower there, as a result, the stress for animals will be less.

The dimensions of the front luggage compartment of my aircraft are as follows:

- Length - 6.2 m;
- Width - 2.1 m;
- Height - 0.74 m.

Therefore, based on this data, I suggest using containers with the following sizes:

- Length - 1m;
- Width - 0.9m;
- Height - 0.7m.

I took these dimensions of the container based on the size of the dog, namely the German Shepherd, whose dimensions are (figure 3.1):

- Height(D) - 60 cm;
- Weight - 35 kg;
- Length(A) - 70 cm;
- Width(C) - 30 cm;
- B = 52% * D = 31 cm.

Considering the size of the baggage compartment and the container, it is possible to fit 2 containers 1 m long in the baggage compartment 2.1 m wide. And also taking into account the length of the baggage compartment, you can fit up to 10 containers of this type, namely for medium-sized dogs.

All container calculations have been followed in accordance with IATA Live Animals Regulations, namely:

Container length = A + ½ B;

Container width = C * 2;

Container height = D.

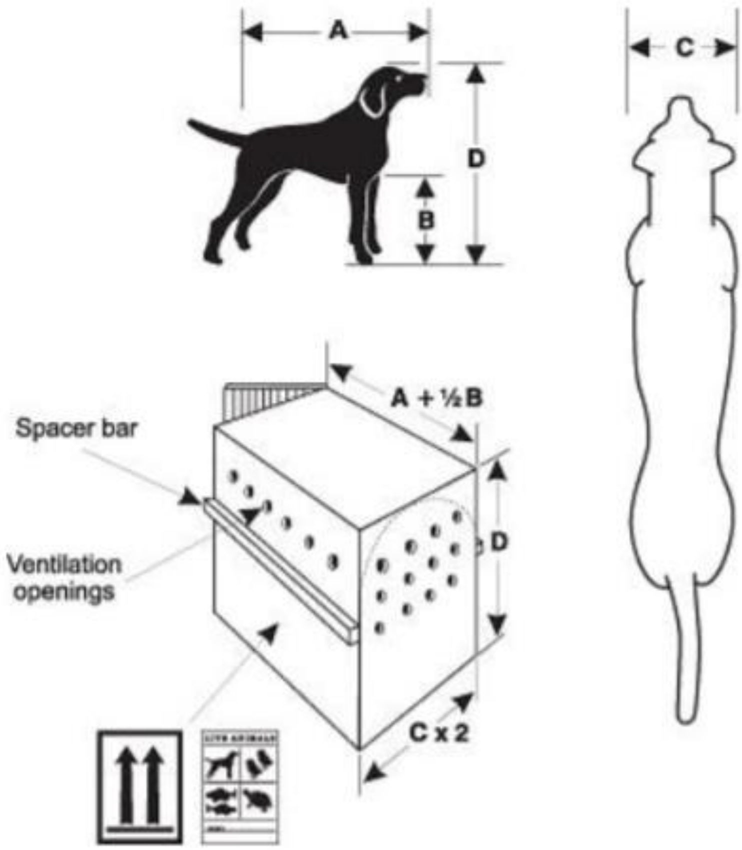

Figure 3.1 – Dimensions of the animal containers

Each animal in the container must have enough space to turn about normally while standing, to stand, to sit erect, and to lie in a natural position.

3.2.2 Construction

The construction of this pet container consists of the following parts:

The body of the container, which includes:

- a door for the animal, as well as a side panel that can also be opened to replace the balloon;
- handles on the sides for easy movement;
- presence of a touch panel for receiving data and interacting with container systems;
- holes for replenishing food and water;

Handling Spacer Bars/Handles must be provided along the middle of both long sides of the container. The floor must be solid and leak-proof. The roof must be solid but ventilation holes are allowed over the whole surface provided that they do not reduce the integrity of the strength of the roof itself. For containers made of wood, plywood of a minimum of 12 mm (½ in) or equivalent material must be used.

System of ventilation;

Ventilation is provided by an open end to the container (which can be the door) and by ventilation openings of a maximum of 25 mm x 25 mm (1 in x 1 in) for dogs and 19 mm x 19 mm (¾ in × ¾ in) for cats over the upper two thirds of the opposite end and the remaining two sides, at a distance of 10 cm (4 in) from center to center of each opening.

Oxygen supply cylinder - essential for maintaining optimal oxygen levels;

Container inside for the animal itself which includes:

- thermometer;
- oxygen level sensor;
- camcorder;
- internal containers for water and food;

Water container must be present within the container with outside access for filling. Food containers must be present either within the container, if sealed, or attached to it for use in cases of delay. Note illustrations are examples only, containers or receptacles that are attached may look different provided they meet the standards described.

- the material on which the animal will be located and which absorbs waste;

External containers for food and water, which are programmed to serve food and water after a certain period of time. Springs for suspension of the inner container. A total of 24 pieces, 3 pieces for each corner. Required to reduce vibration noise.

3.2.3 Materials

1. Carbon fiber. This material will be used for the outer container body as well as the inner container body. The material is characterized by high strength, rigidity and low weight, often stronger than steel, but much lighter.

On top of being strong, carbon fiber:

- Is high in stiffness;
- Is high in tensile strength;
- Has a low weight to strength ratio;
- Is high in chemical resistance;
- Is temperature tolerant to excessive heat;
- Has low thermal expansion;

2. HDPE or polyethylene. This material I use for food and water containers. The material itself is strong enough for these positions and harmless to pets.

High-density polyethylene (HDPE) or high-density polyethylene (PEHD) is a thermoplastic polymer made from ethylene monomer. It is sometimes called "alkatene" or "polyethylene" when it is used for HDPE pipes. Due to its high strength-to-density ratio, HDPE is used in the production of plastic bottles, corrosion-resistant piping, geomembranes and plastic lumber

3. Pet toilet material composition containing silica gel. The absorbent composition is a clay and silica gel with an average pore diameter of about 8 nm to about 10 nm, in which the silica gel is present in the composition in an amount of from about 5% to about 50% and from about 50% to about 95% clay. I choose clay from the group consisting of smectite, attapulgite, kaolin, opal clay and their mixtures. Smectite is calcium montmorillonite or sodium bentonite.

In some aspects of this embodiment, the method further comprises the addition of an odor masking agent, which is preferably a perfume, fragrance, or essential oil. The odor masking agent can be incorporated into the carrier, which can be a silica gel, however, when an odor masking agent is present and the silica gel is used as the carrier material, at least a portion of the silica gel component in the formulation does not contain an odor masking agent. and performs the function of controlling odor.

The absorbent material is used to absorb liquid components of animal waste. In comparison, pet litter formulations containing silica gel and not containing any other absorbent material may become saturated with animal urine, causing liquid waste to merge and accumulate odor in the pet litter material. In contrast, the animal litter box material of the present invention is a mixture of silica gel and absorbent material. Such a component based on clay or other absorbent material serves to effectively wick moisture away from the capillary, which prevents accumulation of liquid.

4. Soundproofing material, that is located between the floors of the outer and inner containers.

Material: noiselayer. Impact noise reduction index from 24 to 32 dB. A mixture of granules of elastic material, a rubber additive and an acrylic-based binder. This soundproofing material has been specially designed to create a damping base. Copes with its task perfectly.

Pros:

- allows you to abandon the installation of a waterproofing layer;
- shrinkage no more than 5% under a load of 5 kPa;
- allows local unevenness of the floor surface up to 15 mm;
- long service life;
- does not lose soundproofing properties during operation;
- simplicity and high speed of application;
- environmental friendliness.

Cons:

- it takes time to dry (about a day).

5. Tempered glass for container door. It is a type of safety glass that is treated with a controlled thermal or chemical treatment to increase its strength compared to conventional glass. When quenched, the outer surfaces are compressed and the inner surfaces are stretched. These stresses cause the glass to break into small granules when broken, rather than into jagged fragments, as is the case with conventional annealed glass. Granular pieces are less prone to injury. Tempered glass is used to ensure its safety and durability in various fields.

3.2.4 Design of container

The front view of the container is shown on the picture (figure 3.2).

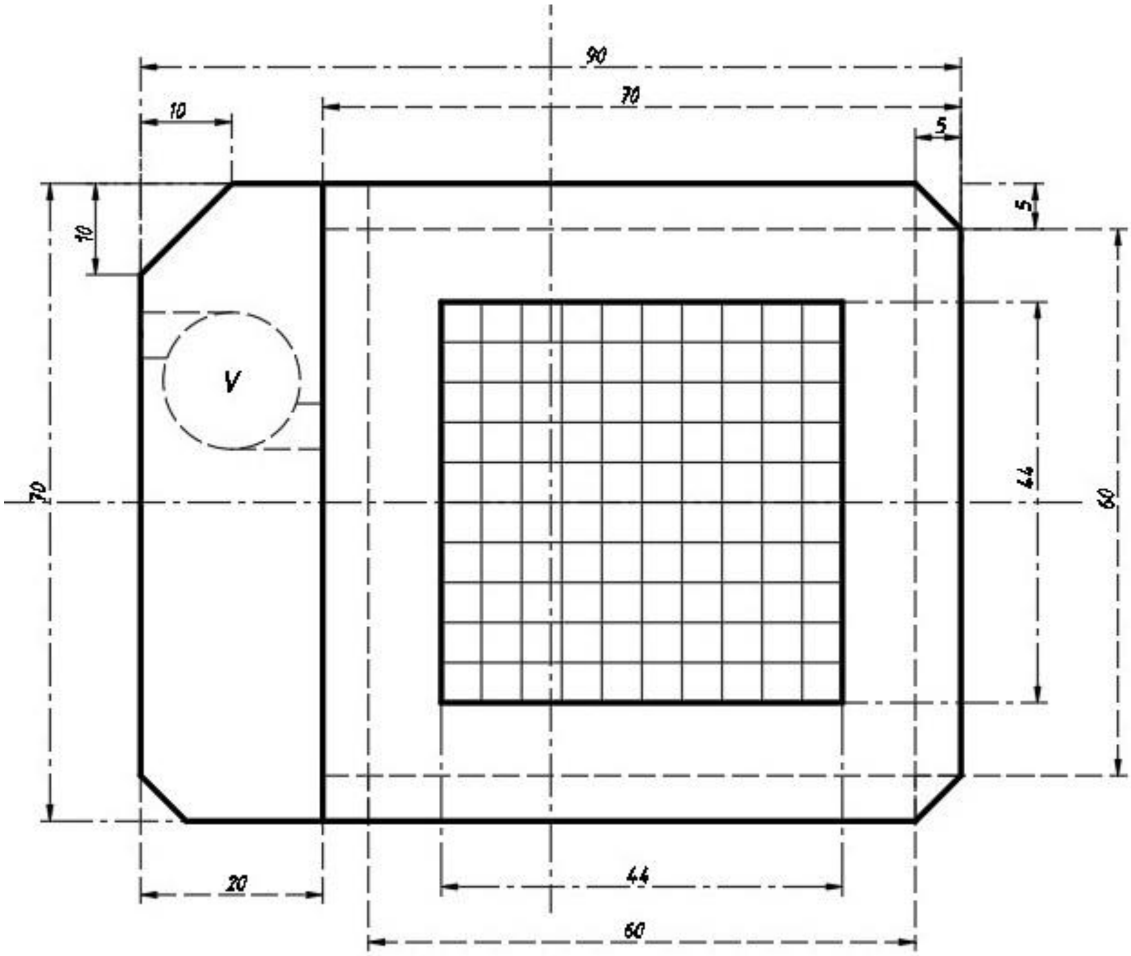

Figure 3.2 - The main dimensions of the containers

The front view shows that the height = 0.7m and width = 0.9m.

This is enough for a German Shepherd, considering that it is considered a medium sized dog. From this we can conclude that most other dogs, which are smaller than a German Shepherd, can easily fit into this container. Even a pair of the same breed. But ideally, smaller containers should be designed for smaller dogs.

The width and height of the inner container is 0.6 m.

The length of the door is 0.7 m and it closes tightly hermetically. As you can see in the drawing, the central part of the door will be made of durable glass, and also protected by a grill so that the dog cannot damage the door.

Also, you can see a 5 cm layer of sound insulation around the inner container. This will create sound insulation for the container, and will greatly reduce the stress for the dog from sounds.

The inner container itself is attached with strong circles to reduce the vibrations that will affect the container, thereby reducing the stress level of the dog.

As you can see in the drawing from the left view, all the key and necessary parts of the container are on the left side (figure 3.3).

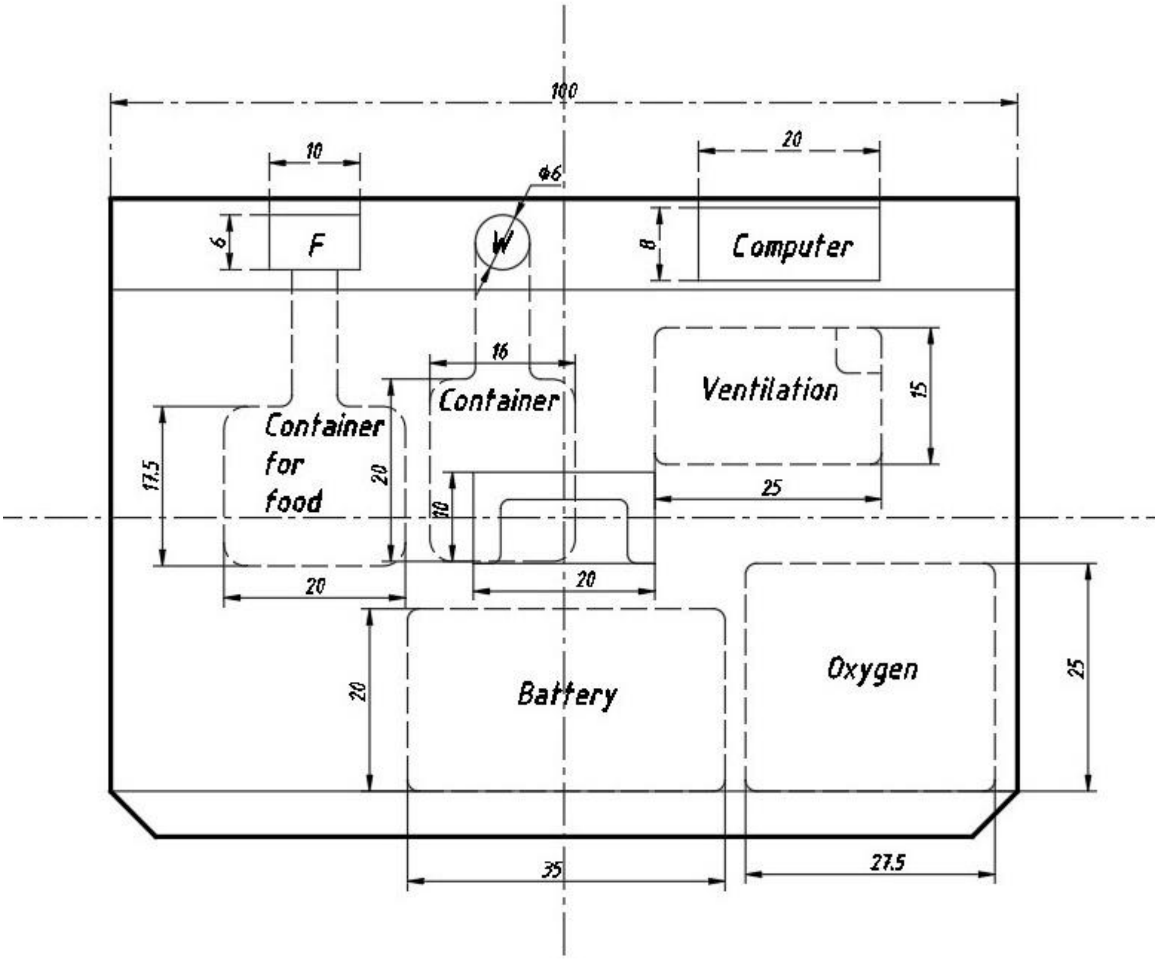

Figure 3.3 - Left view of the container

Namely:

1. Computer. It has the size of a tablet, but that's more than enough to interact with container systems and information output.

It controls:

- The oxygen level in the inner container (if the level is insufficient, opens the valve with a supply of oxygen, so that the animal has something to breathe);

- Temperature in the inner container;
- Battery charge level;
- Counting the time for feeding the animal;
- Transferring a picture from a video camera inside the container to a tablet, which the personnel will have on board;

2. The battery that powers the entire container, namely:

- Ventilation system;
- A computer;
- Video camera;
- Oxygen level sensor;
- Temperature measurement sensor;

3. Balloon with oxygen, serves to supply additional air in case of lack of the required oxygen level;

4. Containers for food and water (as it shown at the top view on fig.3.4), in which they will be stored during the flight and periodically, go into the inner containers for the dog. The computer will keep track of time.

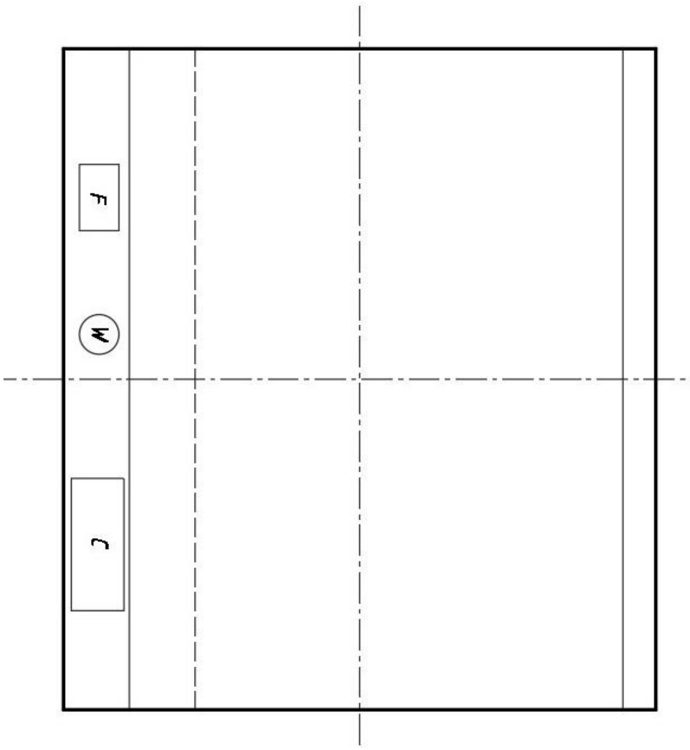

Figure 3.4 -Top view of the container

On this 3D model of my container (figure 3.5) , you can clearly see the following:

- holes for food and water;
- a computer;
- ventilation hole;
- handles for carrying the container;
- strong sealed glass with a lattice;

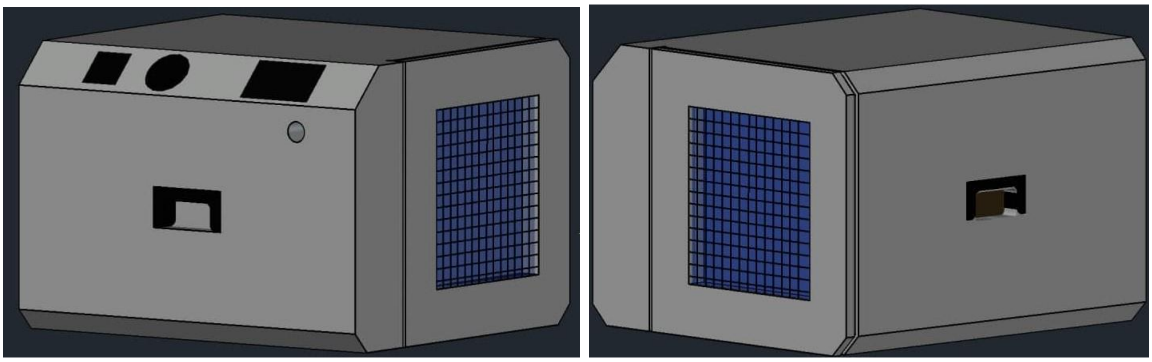

Figure 3.5 - 3D model of container

I will describe the sequence of actions, how I did this container:

- took into account all possible necessary conditions for the animal;
- calculated the dimensions of the inner container for your animal;
- decided on the necessary equipment inside the container;
- calculated the dimensions of the container itself;
- picked up the necessary materials;
- made a drawing of the container;
- made a 3D model according to the drawing.

3.3 Container and rear underground baggage-cargo compartment

The use of containers for animals with the rear underground baggage-cargo compartment (RUBCC), to securely fix the container, so that the container minimally moves, displaces or turns over.

With such a combination, the speed of loading containers, as well as safely as the cargo and service personnel, will increase.

This will also reduce the loading speed, unloading speed, movement in the luggage compartment, which will reduce the physical and psychological stress on the staff.

Loading and unloading of the container in rear UBCC is carried out through the baggage door on the starboard side in the area of SP.

Baggage is fed into the luggage door by a self-propelled conveyor belt from a transport trolley, which is delivered to the plane by an electric vehicle. Luggage is placed manually under the shelves and on the shelves.

The container is loaded into RUBCC in the following sequence:

- open the tailgate;
- unlock the fastenings on the pallet in the luggage compartment;
- load the container onto a pallet;
- fix the container on the pallet;
- push the container into the luggage compartment;
- repeat the steps until all containers are loaded;
- close the tailgate.

Unloading baggage from RUBCC is done in reverse order.

Below are the strength calculations for pallet fixings:

Bearing roller is shown on the figure 3.3.1.

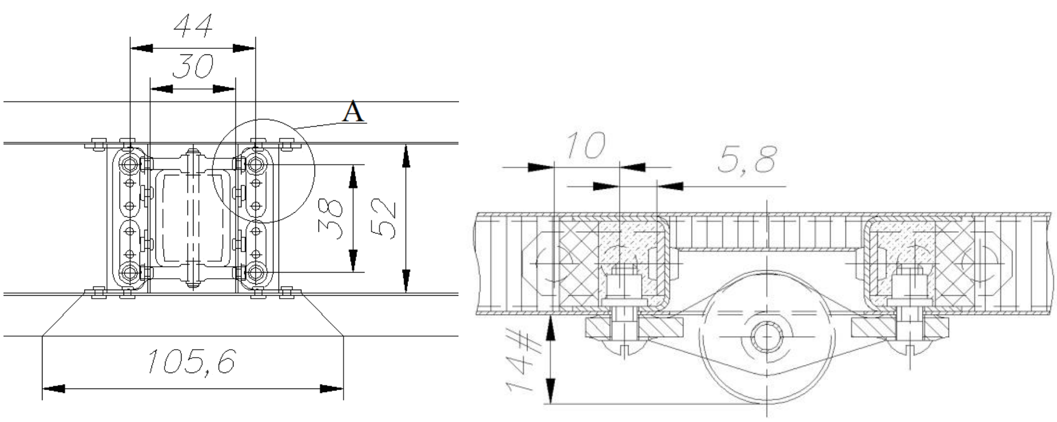

Figure 3.3.1 - Bearing roller

As a result of the calculation, it was found that the maximum design load on the support rollers:

P_y^P = 521 kgf;

Load P_Y^P is taken up by five support rollers:

$$P^p_{Yрол} = \frac{P^p_Y}{5} = \frac{521}{5} = 105 \text{ кгс};$$

The load $P^p_{Yрол}$ is perceived by the four mounting bolts of the support roller:

$$P^P_{Yболт} = \frac{P^p_{Yрол}}{4} = \frac{105}{4} = 27 \text{ кгс};$$

Load on rivet support roller.

Rivet material: B-65.

Rivet diameter:

D=2,6 mm.

Rivet shear resistance D=2,6 mm:

[$P_{ср}$] = 133 kgf.

Due to the fact that the center of the torsion of the rivets of the support roller is at the point of application of force (bolt), the load will be distributed between the four rivets:

$$P^P_{Yзакл} = \frac{P^P_{Yболт}}{n} = \frac{27}{4} = 7 \text{ кгс};$$

Safety factor:

$$\eta = \frac{\left[P^p_{ср}\right]}{P^P_{Yзакл}} = \frac{133}{7} > 3.$$

Guide roller is shown on the figure 3.3.2

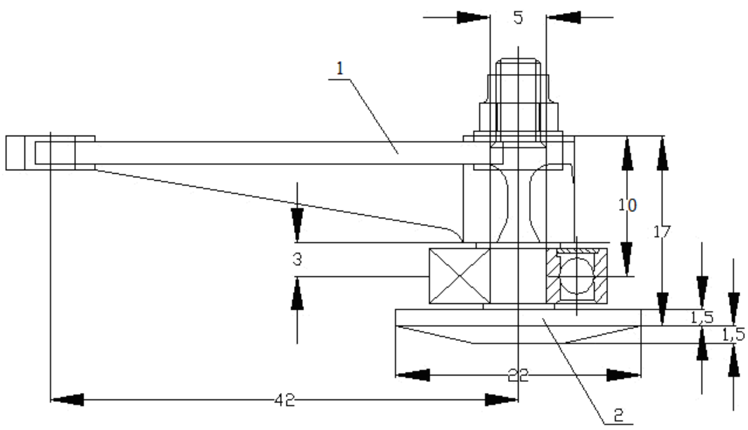

Figure 3.3.2 – Guide roller

1 - Bracket 2 - Fungus

Fungus

Material: 07Х16Н6-Ш;

$\sigma_B = 12000$ кг/см^2;

As a result of the calculation, the loads on the guide rollers of the pallets of the underground BCC were obtained.

Calculated case: $n_Y^P = -3,2$ $n_Z^P = \pm 1,35$;

Design load P_Z^P, coming to the two guide rollers of the rear UBCC:

$P_Z^P = -325$ кгс;

Calculated load on one guide roller:

$$P^P_{Z\ \text{рол.}} = \frac{P_Z^P}{2} = \frac{325}{2} = 163 \text{ кгс};$$

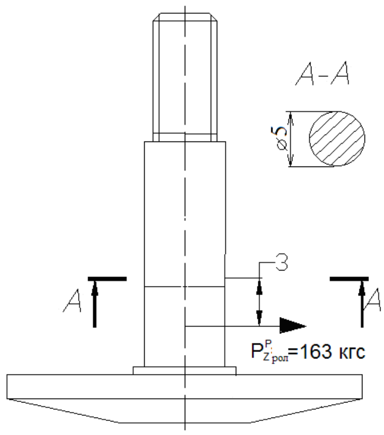

Figure 3.3.3 – Guide roller fungus

Figure 3.3.3. Load application diagram $P^{P}_{Z\ \text{рол.}}$ on the guide roller fungus

Check section A-A for strength:

The moment of resistance of section A-A:

$$W_{A-A}=\frac{\pi\cdot d^{3}}{32}=\frac{\pi\cdot 0,5^{3}}{32}=0,0123\ \text{см}^{3};$$

Moment in section A-A:

$$M_{X}^{P}=P_{Z\ \text{рол}}^{p}\cdot l=163\cdot 0,3=49\ \text{кгс}\cdot\text{см}$$

Tension in section A-A:

$$\sigma_{изг}^{P}=\frac{M_{X}^{P}}{W_{A-A}}=\frac{49}{0,0123}=3984\ \text{кгс/см}^{2};$$

Safety factor:

$$\eta=\frac{\sigma_{в}}{\sigma_{изг}^{P}}=\frac{12000}{3984}=3.$$

Calculated case (d) $n_{Y}^{P}=2,5$:

Due to the fact that the luggage is not fixed on the pallet, we find the calculated load on the guide rollers only on the weight of the pallet:

$P_Y^P = M_П \cdot n_Y^P = 30 \cdot 2,5 = 75$ кгс;

Design load P_Y^P perceived by four rollers:

$$P_{Y\,\text{рол}}^P = \frac{P_Y^P}{n} = \frac{75}{4} = 19 \text{ кгс};$$

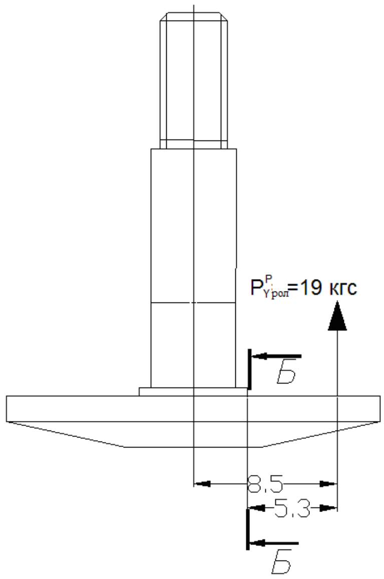

Figure 3.3.4. Load application diagram $P_{\text{Y рол.}}^P$

on the guide roller fungus

Moment in section B-B:

$M_X^p = P_Y^p \cdot l = 19 \cdot 0,53 = 10,1$ кгс·см;

Tension in section B-B:

$$\sigma_{изг}^P = \frac{M_X^P}{W_{Б-Б}} = \frac{10,1}{0,025} = 403 \text{ кгс/см}^2;$$

Safety factor:

$$\eta = \frac{\sigma_B}{\sigma_{изг}^P} = \frac{12000}{403} > 3.$$

Bracket

Material: 08Х14Н5М2ДЛ

$\sigma_B = 12500$ кг/см^2;

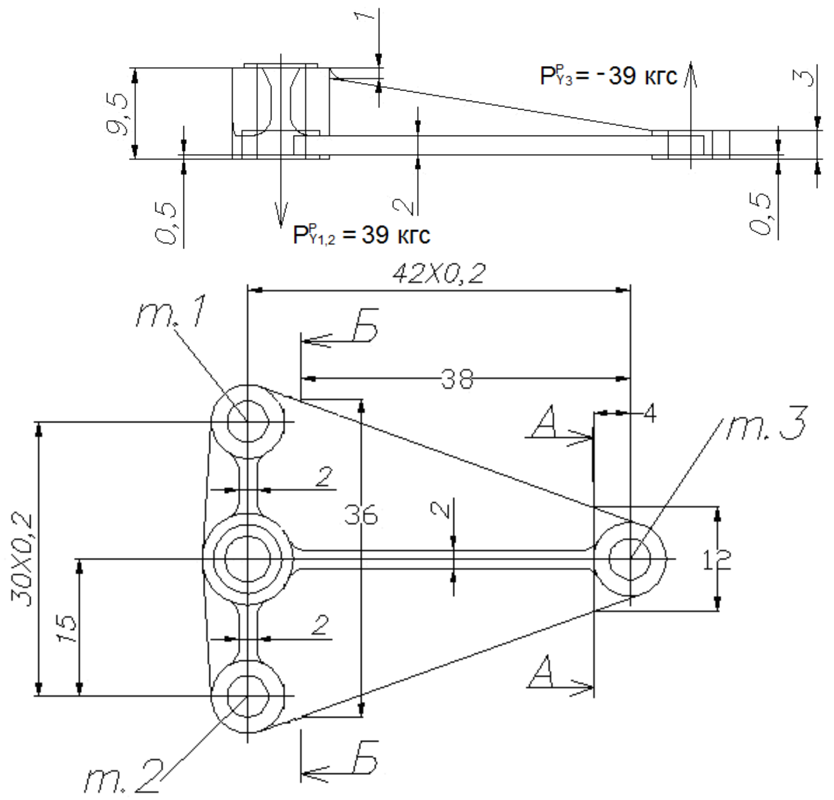

Figure 3.3.5. Bracket

Design load $P^P_{Z\text{ рол.}}$ perceived at points 1, 2 and 3:

$$P^P_{Z1} = P^P_{Z2} = P^P_{Z3} = \frac{P^P_{Z\text{ рол.}}}{3} = \frac{163}{3} = 54 \text{ кгс};$$

Moment of action of the load $P^P_{Z\text{ рол.}}$:

$$M^P_X = P^P_{Z\text{ рол.}} \cdot l_1 = 163 \cdot 1{,}0 = 163 \text{ кгс} \cdot \text{см};$$

The moment is perceived at points 1, 2 and 3:

$$P_{Y1,2}^{P} = -P_{Y3}^{P} = \frac{M_{\mathrm{X}}^{P}}{l_2} = \frac{163}{4,2} = 39 \text{ кгс};$$

Moment in section A-A:

$$M_X^P = P_{Y3}^P \cdot l = 39 \cdot 0,4 = 16 \text{ кгс} \cdot \text{см};$$

Tension in section A-A:

$$\sigma_{изг}^{P} = \frac{M_X^P}{W_{A-A}} = \frac{16}{0,007} = 2230 \text{ кгс/см}^2;$$

Safety factor:

$$\eta = \frac{\sigma_B}{\sigma_{изг}^{P}} = \frac{12500}{2230} > 3.$$

Moment in section B-B:

$$M_X^P = P_{Y3}^P \cdot l = 39 \cdot 3,8 = 148 \text{ кгс} \cdot \text{см};$$

Tension in section B-B:

$$\sigma_{изг}^{p} = \frac{M_X^P}{W_{A-A}} = \frac{148}{0,034} = 4353 \text{ кг/см}^2;$$

Safety factor:

$$\eta = \frac{\sigma_в}{\sigma_{изг}^{P}} = \frac{12500}{4353} = 2,9.$$

Conclusion to the part

As a result, we have a container that will allow the animal to survive in almost all cases of transportation, avoiding stress, loud sounds, vibration, lack of oxygen, falling / overturning / displacement of the container and other problems that occur when transporting animals.

PART 4. LABOR PROTECTION

Work on transportation of animals using special containers for animals. The maintenance personnel must know the operation of the container, be familiar with the animals, and understand what is dangerous for him and what is not.

4.1 Analysis of harmful and dangerous production factors

The container can weigh from 30 to 50 kg each and have different dimensions, depending on the animal inside the container.

The container has everything necessary for comfortable conditions during transporting animals.

When loading animals on board, the personnel must be concentrated, careful and not disturb the animal again. Animals are afraid of stress, loud noises, incomprehensible vibrations, shocks.

During the flight, the personnel only need to observe the data received from the container, monitor the condition of the animal and feed it from time to time.

For the maintenance personnel, the animal itself and the weight of the container are dangerous, therefore, when working with the container, the personnel must be as careful as possible, do not irritate the animal, so that it does not get mad and feel comfortable.

Therefore, to work with containers, the attendants must also be familiar with the animal and how to behave with it. What it can be fed with and what not. To be able to operate the container, understand the state of the animal and be able to act in various situations that have arisen.

According to the standard ГОСТ 12.0.003-74 we have list of harmful and dangerous working factors, which can impact on the workers.

Let’s find out and analyze which dangerous and harmful factors working with that medical containers can take.

1) Physical factors.

Working with containers has practically no physical hazards, with the exception of loading. It is necessary to be careful with the container in which the animal is located, so as not to drop it, not to damage the container, so that the animal does not suffer and that the attendants are not injured.

Also harmful physical production factors include:

- moving parts of production equipment; moving products;
- increased or decreased temperature of surfaces of equipment, materials;
- increased noise in the workplace;
- increased vibration level;
- high or low humidity;
- increased level of static electricity;
- increased level of electromagnetic radiation;
- direct and reflected brilliance;
- location of the workplace at a significant height relative to the ground (floor);

2) Psychophysiological factors

As for psychophysiological factors, this work includes both physical and psychological stress.

Physical means work with a container, its delivery and loading on an airplane, tension of body muscles, namely, arms, legs, abs, back and lower back. Therefore, if the container is carelessly treated, consequences are possible, namely damage to body parts, if the container falls on a person.

And on the mental side, this is increased concentration, increased responsibility for animals, responsibility for the container, and so that nothing happens to it, or otherwise the animal will suffer. And since the animal can be expensive and even very much more expensive than the monthly salary of the service personnel, and if the animal suffers, the company will incur losses, which is very unacceptable, and the employee may receive a reprimand and a fine.

Also, when servicing the container when pouring, there is also an increased concentration and caution when following the animal through the cameras. And if you do not notice something wrong with the container or with the animal inside in a timely manner, the animal may suffer, which will eventually suffer consequences.

3) Chemical factors.

No chemically hazardous substances.

4) Biological factors.

As for biological factors, the only thing that can harm the maintenance personnel is allergies to different animals, their fur, etc.

Therefore, it is necessary to know, find out, or check which of the maintenance personnel may have allergies and who may not.

4.2 Measures to reduce the impact and dangerous production factors

Sound energy emitted by the noise source is distributed over closed surface S surrounding the source and passing through calculated point. On the way, this energy is weakened by a factor of β due to losses in fences 2 and 3, atmosphere, green spaces, etc. Therefore, sound intensity at the design point taking into account the directivity of the source will be (W / m2):

$$I = P\Phi / \beta S$$

The basic acoustic calculation formula is:

$$L = LI = LP + 10 \log \Phi - 10 \log - \Delta LP, (1)$$

where LP is the sound power level of the noise, dB;

S_0 - unit area equal to 1 m^2;

$\Delta LP = 10 \log \beta$ - attenuation of sound energy along the path from the noise source to design point due to its reflection and transition to other forms of energy (usually in warmth), dB.

Based on this formula, you can determine the main directions noise control by technical means.

These include:

1) decrease in the sound power of the source;

2) using the directivity of the source (or the exit connected to the source of the pipeline) so that the maximum of the directivity characteristic was turned either upward or in side of buildings or terrain for which the permissible level noise is the highest or not standardized; 3) an increase in the area of the closed surface S, on which the sound power

of the source is distributed, which is achieved by architectural and planning solutions (noise sources should be located as far as possible from workplaces);

4) increased attenuation of sound energy ΔLP between the source noise and workplace through soundproof barriers (walls, floors, casing, observation cabins, etc.), sound-absorbing facings and sound-absorbing structures, screens, silencers, vibration isolators. It is possible to use noise-suppressing devices with negative acoustic feedback (noise reduction provided by the same noise supplied in the opposite phase at assistance of radio equipment with an external noise). Personal protective equipment also increases the ΔLP.

The formula (1) has a general character and is derived from the energy conservation law for acoustic phenomena. In various specific cases, it can be reduced to one form or another that is convenient for practical calculations.

Having determined the octave levels L at the workplace by calculation or by measurement, the required efficiency of noise reduction measures for each octave band is found

$\Delta L_{req} = L - L_{per}$,

where L_{per} is the permissible sound level.

Sound insulation of a structure (partitions, walls, windows, etc.) as a physical quantity is equal to the attenuation of the intensity of sound when it passes through this structure:

R = 10 log (I pad / I past),

where R is the physical value of the sound insulation of the structure, dB;

I pad - the intensity of the incident sound, dB;

I last is the intensity of the transmitted sound, dB.

The easiest and cheapest way to reduce noise in production premises is the device of soundproofing casings that completely cover the noisiest units.

Noise is reduced by the use of sound-absorbing materials. Sound-absorbing materials and structures are called that can absorb the energy of the air sound falling on them. This is usually structures consisting of porous materials. They are used either in the form linings of interior surfaces of premises, or in the form independent designs - piece absorbers, usually suspended from the ceiling. As piece absorbers use also draperies, soft chairs, etc.

The surface of a sound-absorbing lining is characterized by a sound absorption coefficient α equal to the ratio of the intensity of the absorbed sound to the intensity of the incident sound.

α = I absorption / I pad.

The sound absorption coefficient depends on the type of material, its

thickness, porosity, grain size or fiber diameter, the presence of an air gap behind the material layer and its width, frequency and angle of incidence of sound, size of sound-absorbing structures, etc. For an open window, $\alpha = 1$ at all frequencies.

4.3 Occupational Safety Instruction

1) General labor protection requirements

1.1) Maintenance person is allowed to work with container for animals, who have reached 18 years, passed certification, have a document confirming the completion of courses on working with an animal’s container.

Repeated instruction on labor protection must be carried out at least once every six months.

1.2) When working with animal’s container, the personal must:

1.2.1) Follow the internal labor regulation;

1.2.2) Know animal’s features;

1.2.3) Inform pilots in case of any dangerous incidents;

1.2.4) Follow the rules of conduct on the plane;

1.2.5) Undergo examinations, training (education), retraining, advanced training and knowledge testing on labor protection issues in the manner prescribed by law.

1.2.6) Know how to work with the container, know all its functions and what parameters it displays.

1.2.7) Know in accordance with qualifications: technical conditions and standards for instruments and devices, apparatus and other equipment; design and operational features of controlled products; types of defects during assembly, installation, repair and maintenance; device and rules of operation of instrumentation; methods of control and adjustment of devices, apparatus and other equipment; rules for the preparation of technical documentation.

2) Labor protection requirements before starting work

2.1) Check the shelf life of the items in the animal's container;

2.2) Make sure that the animal is healthy and in good health, nothing threatens him;

2.3) Check the completeness and serviceability of instrumentation and instruments, equipment, fixtures, operability, lighting, collective protection means;

2.4) The identified violations of labor protection requirements must be eliminated before starting work, if this is impossible, the person is obliged to report the shortcomings in ensuring labor protection to the direct main pilot.

3) Requirements for labor protection at work

3.1) When performing work, it is necessary:

3.1.1) Carry out only that work for which the service personnel are trained, instructed in labor protection and to which the person responsible for the safe performance of work is admitted;

3.1.2) Be sure to entrust your work to untrained and unauthorized persons, only in urgent cases;

3.1.3) use serviceable equipment and tools necessary for safe work, use them only for the work for which they are intended;

3.1.3) comply with the rules of movement on the aircraft;

3.1.4) Keep the workplace clean and tidy, do not overload it with foreign objects.

3.2) When performing work, it is not allowed:

3.2.1) Reach out and take something through the equipment;

3.2.2) Carelessly treat the animals;

3.3) Transport animals only in an undamaged container;

4) Requirements for labor protection in emergency situations

4.1) In the event of an emergency, you should:

4.1.1) Immediately disconnect the source that caused the accident (in the event of a situation that caused the electrical equipment);

4.1.2) stop all work not related to the elimination of the accident;

4.1.3) Take first aid measures (if there is an injured animal);

4.1.4) take measures to prevent the development of an emergency situation and the impact of traumatic factors on other persons;

4.1.5) inform the main pilot about the incident;

4.2) In the event of a fire, the pilot must be informed of the incident and measures must be taken to extinguish the fire with the available fire extinguishing means. The use of water and foam fire extinguishers for extinguishing live electrical equipment is not allowed. For these purposes, carbon dioxide and powder fire extinguishers are used, located in the front and rear of the fuselage and the luggage compartment;

5) Requirements for labor protection at the end of work

5.1) Disconnect electrical equipment;

5.2) Check the condition of the animal;

5.3) Check all indicators from the container;

5.4) Remove the container from the luggage compartment, carefully and without haste;

Conclusion to the part

Following from all that is listed above, all ГОСТ standards and optimal working conditions for service personnel are met. The presence of possible future damage, illness, or whatever is minimal.

PART 5. ENVIRONMENTAL PROTECTION

The theme of my thesis concerns the creation of containers for transporting animals in the luggage compartments of aircraft. As for the harm to the environment, it is safe to say that there is no harm from the word at all.

5.1 Influence of the container on the environment

How does the whole process work? The animal, after being thoroughly checked for diseases and other problems, as well as for general health, is immersed in a container. Before loading the animal, the container itself is checked for operability, for readiness to be ready to accept the animal, without harm to the animal itself. The container is also checked for food and water, in case of long journeys and so that the animal does not suffer from a lack of food or water.

After checking the container, the animal is loaded into the container. I'll tell you a little about the container itself. Consists of non-hazardous materials, since no toxic materials are used inside the animal and in order for it not to be harmed. The body itself is made of impact-resistant plastic.

The container is then loaded into the hold of the aircraft. No emissions, no waste, nothing dangerous and harmful to both the operating personnel and the environment in general. All animal waste will be disposed of after the container arrives at its destination. For this, a special material is used that absorbs animal waste.

It is also worth noting that since animals are part of the environment, the very idea of creating a safe container helps to preserve the environment. The reason for creating such a container is that when transporting animals in simple containers in the luggage compartments, animals can often die. But since death does not always occur, animals, in addition to death, receive very strong stress. Stress due to loud noises, lack of oxygen, lack of fasteners on the container, as a result, the container can move, hit, roll over and fall, which is extremely undesirable for the state of the animal.

5.2 Possible causes of container failure

- There is an oxygen cylinder inside the cylinder. If the container is damaged, oxygen can be released, leaving the animal without air, leading to its death.
- The battery can malfunction, which can lead to a shutdown of systems, namely the computer, ventilation, food and water supply, thereby leading to adverse outcomes.
- Ventilation. If the air inlet is closed, it will also leave the animal without oxygen.

But since the design of the container ensures maximum comfort and safety of the animal, the death rate of animals in the luggage compartments of the aircraft, according to calculations, should be reduced by an order of magnitude, if not completely. Only if these containers are used.

5.3 Additional features

Specially designed chambers with containers for transporting animals will not only increase the safety of transporting animals, but also make it possible to transport certain products that cannot be transported in another form (freezing, conservation), and which have been transported in similar chambers until now, but by land. and, accordingly, their price is prohibitively high, which negates the general sense of transporting these food products or plants, especially from one continent to another. Also, these cameras can be used to transport drugs and pharmaceutical substances that are sensitive to temperature changes.

Conclusion to the part

Considering all of the above, it can be concluded that these containers for transporting animals in the luggage compartments of aircraft do not pose a threat to the environment, including for animals and service personnel.

GENERAL CONCLUSIONS

Based on all the information in my diploma, in which I combined the idea of creating conditions for the safe transportation of animals with the achievements of modern technology, you can see some of the nuances of introducing a container for transporting animals.

Firstly, you need finances to buy cameras, boxes and other equipment (tablets, camcorders, operating systems, etc.)

Secondly, finance is also needed to train service personnel to be able to track the selected parameters of keeping animals in conditions of transportation on tablets and respond in accordance with the situation of temperature rise, water or food supply, and other possible problems.

In general, these are the only drawbacks associated with equipping the aircraft with this equipment, but nevertheless, they only suggest a one-time tranche for the purchase of all the necessary equipment, and payback expenses for maintenance. But the undoubted advantage of such airlines will be the influx of passengers with animals, who will definitely be confident in the safety of their pets and will agree to pay for the appropriate comfortable conditions. This innovation will become a "chip" of the company in addition to a single complex of social responsibility both to a person and his property, and to global humanistic trends.

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