PROCEDURE FOR PRELIMINARY DESIGN OF THE CHASSIS OF TRANSPORT AIRCRAFT

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Annotation. This article discusses the components, schemes, designs and chassis designs of modern transport aircraft. The strength calculation shows that the chassis design meets the general and strength requirements for transport aircraft. The article will develop a procedure for preliminary design of the chassis of transport aircraft. The developed algorithm for comparing the source data with statistical data provides for data exchange with the project database. In addition, the possibility of exchanging design data allows you to dramatically reduce the amount of data entered into the model, in particular, into the general elementary model of the airframe, and provides automatic connection of the chassis mounting units with the airframe batteries. The developed procedure systematizes the data, reduces the time to determine the main parameters of the chassis and reduces the likelihood of errors.

Keywords: transport aircraft, runway, chassis components, chassis design, basic chassis parameters, elementary airframe model.

Introduction
Aircraft carrier (AC) are designed for tactical transportation and landing of cargo. Depending on the method of application and take-off weight, the AC chassis provides the ability to take off and land on concrete and ground runways.

The article introduces the procedure for preliminary design of the chassis of transport aircraft, which is a systematization of data on the component tasks of the aircraft chassis design process.

The preliminary design procedure of the chassis includes the following stages: development of the scheme, structure and counteraction, as well as its constituent elements, ensuring the most effective execution of the AC chassis under certain restrictions.

Description of the main stages of the chassis design procedure
To solve the problems of preliminary design of the chassis of a transport aircraft, a special procedure has been developed that allows us to slightly reduce the time for determining the main parameters and reduce the likelihood of errors. The procedure for preliminary design of the chassis of a transport aircraft includes the following main stages:
- direction of input of initial data (AC take-off weight, runway type, aerodynamic alignment, cargo floor height and. B.);
- comparison of primary data with data from statistical databases;
- calculation of chassis parameters;
- output of calculation results;
Determination of initial data during chassis design

The AC chassis [1-3] is designed for its movement on the runway during acceleration, running and ground travel. The chassis diagram (Figure 1) is determined by the number, mutual arrangement and shape of the main units: supports, shock absorbers, wheels, cylinders for collecting and removing the chassis, locks in the assembled and removed state, as well as spaces. The scheme of the chassis and their parameters determine the stability and manageability characteristics of the AC during its movement on the runway, affect the load on the supports and individual parts of the AC, as well as their weight characteristics. The main geometric parameters of the chassis scheme are as follows: longitudinal base \(-b\); Blackbird \(-B\); chassis height \(-h\); removal of the main supports relative to the center of gravity \(-e\); corners: parking \(-\phi_{ст}\) (When standing, the angle between the fuselage axis and the ground plane), landing \(-\phi_{0}\) direction (the angle between the axis of the fuselage and the line connecting the point of contact of the main supports and the runway wheels with the safety support in the fuselage), \(\beta\) – the angle of removal of the main supports and the angle that characterizes the track \(-\theta\).

Figure 1 - Diagram of the designed chassis

Calculation of basic chassis parameters

According to the selected chassis scheme in the picture.1 the value of the parking load for take-off and landing weight is determined:
where \( i = 1, 2 \)- take-off and landing mass, respectively, \( n \)- the number of wheels on one main rack. Determining the working pressure in pneumatics:

\[
p_{\text{раб}} = \frac{p_{\text{ст.взл}}}{p_{\text{нор}}} p_{\text{нор}}
\]

We define the normalization by the formula:

\[
\delta^* = \frac{D_G - R^*}{2}, \delta_{\text{ст.пос}} = \frac{p_{\text{ст.пос}} \delta^*}{p_{\text{ст.взл}}}
\]

In this case, the conditions are met:

\[
P_{\text{ст.взл}} < P_{\text{нор}}; \quad p_{\text{раб}} < p_{\text{нор}}; \quad V_{\text{взл}} < V_{\text{нор}}.
\]

Landing angle \( \varphi_0 \) – during landing, the aircraft does not touch the tail of the fuselage to the ground. This condition should be written as follows:

\[
\alpha_{\text{пос}} \leq \varphi + \alpha^\text{ycr}.
\]

Usually \( \varphi_0 = 8^\circ \div 14^\circ \). Large angle values \( c_{y_{\text{max}}} \) refers to AC with triangular wings, which is achieved at large angles of attack. It should be noted that the increase in landing angles is related to the need to increase the length of the chassis supports, which is an inefficient weight ratio and creates additional difficulties in cleaning them in flight.

\[
f_{\text{бок}} \leq \frac{aB}{2h \sqrt{(0.5B)^2 + b^2}}
\]

At the same time, the stability conditions are met: the angle against the hood is \( \beta \geq \varphi_0 \); The angle of rotation of CA is equal to \( \theta \geq 37^\circ \); depreciation is determined by the following formula:

\[
\frac{mv^2}{2} = n^3 m g (\eta_{\text{ам}} \cdot s + \eta_{\text{пн}} \cdot \delta),
\]

where \( \eta_{\text{ам}} \)- is the completeness coefficient of the shock absorber diagram; \( V_{\text{нор}} \)- suitable shrinkage rate \([4]\); \( \eta_{\text{пн}} \)- pneumatics efficiency coefficient.

Calculate the vertical stroke of the wheel when landing:

\[
s = (\frac{v^2}{2n^2g} - \eta_{\text{пн}} \cdot \delta_{\text{ст.пос}}) / \eta_{\text{ам}}.
\]
Let’s look at the liquidity of aircraft carriers on the runway. For aircraft intended for use on a concrete runway, for support with paired wheels, there is the following formula:

\[
P_{экв} = 0.2831 \left( \frac{1}{1+0.0352(p_0 \cdot 10^{-5})^{2/3}} \right)^{1.75},
\]

(1.9)

where \( P_{ст.взл} \) - parking load per wheel;
\( p_0 \) - pressure in chassis pneumatics;
\( k_{ш} \) - structural coefficient and wheel diameter depending on the type of support.

\( P_{экв} \) - equivalent single-wheeled load the load from the single-wheeled support of the carrier aircraft, which is equal in force to the effect of force to contribute to the closure of the load from the actual support of the carrier aircraft (taking into account the number, size and layout scheme of the wheels on this support) corresponding to a given class of runway to be used by the aircraft. It is observed that the use of a large number of small diameter wheels in the aircraft leads to an improvement in its conductivity. When using a carrier aircraft on a ground runway, the condition of liquidity of the carrier aircraft is determined by the formula:

\[
\sigma_{min} = \frac{P_{ст.взл}}{\delta_k B_k \sqrt{H_k D_k}},
\]

(1.10)

where \( P_{ст.взл} \) - parking load per wheel;
\( H_k \) - allowable track depth;
\( B_k \) - round width;
\( D_k \) - wheel diameter;
\( \delta_k \) - coefficient that takes into account the deformation of pneumatics in the contact zone with the ground (Figure 2).

Figure 2 - Dependence of \( \delta_k \) on \( \sigma \)

The \( \sigma_{min} \) value found by the formula is compared with the value given in the tactical and technical specification and makes a conclusion about the aircraft’s liquidity on the ground. Calculation of \( \sigma_{min} \) the norm condition \( \leq \sigma_{min} \) must be met.

Thanks to the use of large-scale pneumatics, it is possible to expand the ground-based areas of aircraft within certain, but clearly low limits.
The main support of the chassis consists of three 2-wheel supports standing one after the other with a lever loop; (Figure 3 shows the model of the chassis support in the SAD/SAM/SAE-CATIA V.5 system) two brake wheels, a shock absorber, a hydraulic collection and release cylinder. The chassis uses Meridional pneumatics. Calculated vertical load on the support [5]:

\[ P_z^p = 2f \cdot P_{ct,\text{ins}}, \]

where \( f \) – safety factor.

**Chassis preliminary design program**

The algorithm of the program for preliminary design of the AC chassis is shown in Figure 4.

The procedure for comparing primary data with statistical data involves exchanging data with a project database. In addition, the ability to exchange data with design models, including with the general finite element of the glider, dramatically reduces the number of input data and provides automatic connection of chassis mounting nodes to the power elements of the glider [5, 6].

Figure 5 shows an example of calculating the parameters of the power beam of an aircraft that accepts the load of the chassis, made using the tools” Patran/Nastran".

The program includes the following main modules (Figure 6):
- main control module;
- user interface support module;
- data exchange module from the database;
- module for calculating chassis parameters;
- results analysis module.

The program is developed in an object-oriented programming environment and works in interaction with the object-oriented database management system "SPACE" [8].
Figure 4. Algorithm of the chassis preliminary design program

Figure 5. Structure of the chassis preliminary design program

**Conclusion**

In this article, the schemes, structures and design of modern transport aircraft, as well as the components of the chassis, were considered. The strength calculation shows that the design of the chassis meets the general and strength requirements for the AC.

In the article, a preliminary design procedure for the chassis of a transport aircraft was developed. The developed algorithm for comparing primary data with statistical data provides for the exchange of data with the project database. In addition, the ability to exchange data with design models, in particular with the general elementary model of the glider, allows you to dramatically reduce the number of data entered and provides automatic connection of chassis mounting nodes to the power elements of the glider.
The developed procedure systematizes data on the design of the chassis of transport aircraft, reduces the time for determining the main parameters of the chassis and reduces the likelihood of errors.

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