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# INVESTIGATION OF THE INFLUENCE OF GEOMETRICAL PARAMETERS ON THE TAKE-OFF MASS OF UNMANNED AIRCRAFT WING

## 1 Introduction

The aim for carrying out investigation on the wing parameters of an unmanned aircraft take-off mass is to look for its geometrical and structural weakness so as to be able calculate and deduce new parameters that will increase the general performance of the aircraft, thus reducing its take-off mass. These parameters include the relative airfoil thickness, aspect ratio, taper ratio and sweep angle. Along the line in the research, limits are used to define load factor and landing speed. These limits are used, as when displayed on the graph, give the ability to determine the minimal mass within the limit range.

## 2. Investigation

2.1 Work description

As earlier stated, the geometrical parameters of the aircraft greatly influence its takeoff weight. Geometric parameters of the wing have the greatest influence on the aerodynamic characteristics of the aircraft. For this proposed study, the first four basic parameters proposed by the software which are relative thickness, aspect ratio, taper ratio and sweep angle are used. They are then corresponded to seven different aircraft parameters which are lift to drag dependency, specific thrust, relative mass of power plant, relative mass of fuel, relative structural mass, optimal cargo mass and take off mass. Scientific article proposes a study on the basis of these parameters. Increase in wing aspect ratio generally leads to improved aerodynamic performance and increases weight.

Improving aircraft parameters can be achieved in two ways. Which are improving the aerodynamics and reducing the take-off weight. The first way is the obvious. But the second way also allows for significant improvement in the parameters of the aircraft. If takeoff weight is reduced, the under the same aerodynamic characteristics of the aircraft can carry more payload. This is valid for both civil and military aircraft.

Four basic parameters are specifically chosen because they play an important role in the aerodynamic and mass characteristics of the aircraft. So the investigation will focus on these 4 parameters as the investigation proceeds. Then decision about which values are best for a reduced mass and increased aerodynamic performance will be finely selected.

2.2 Steps taken into the investigation

On Figure 1 steps taken into investigation are shown.

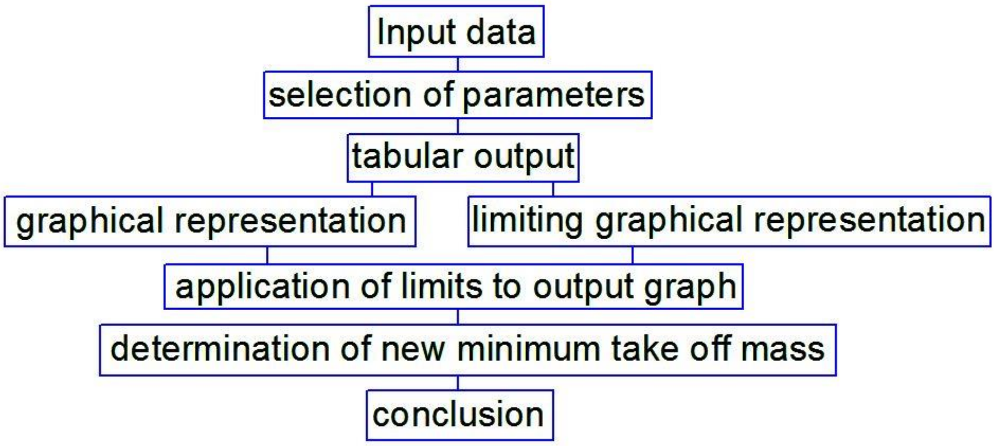


**Figure 1. Investigative procedures**

Using the TM software of department of Design airplanes and Helicopters of National Aerospace University, available data's of the aircraft gotten from initial design of the zero approximation stage are been inputted. Calculations of seven flight parameters are made, which are lift to drag ratio, specific thrust, relative mass of power plant, relative mass of fuel, relative structural mass, optimal cargo mass and take off mass. These above stated 7 calculations are done for the 4 chosen parameters. So, in total 28 different results are received of the 4 parameters relating to the take-off mass and a limiting mass graph is designed for them (Figures 2-4).

Graphs of limits definition

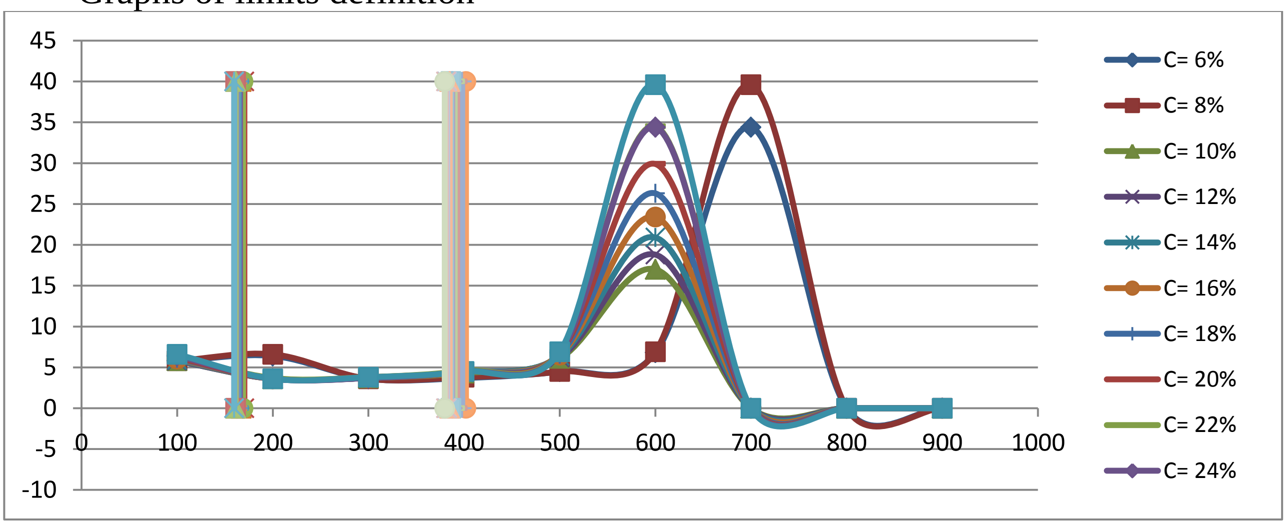


**Figure 2. Graph of variable c, %**

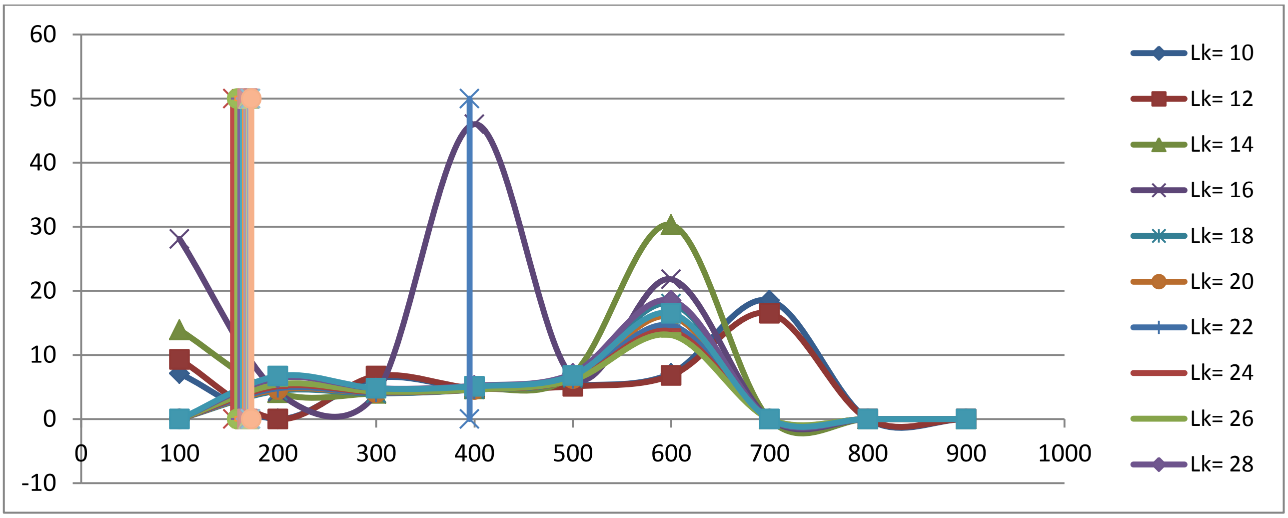


**Figure 3. Graph of variable $\lambda$**

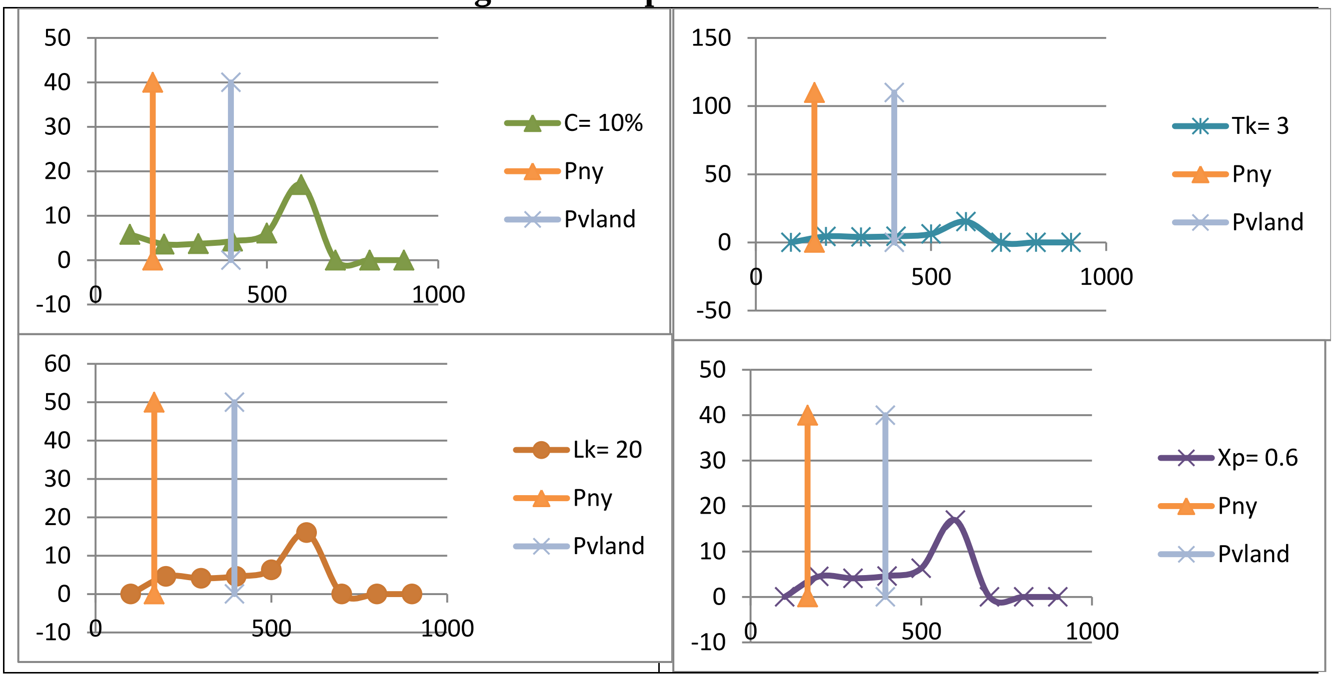


**Figure 4. Limiting graphs for specified parameters gotten from zero approximation design**

As we can see take-off weight changes in a wide range. But in reality, there are some limitations that depend on various factors. In research two limitations have been taken. They are overload limit and the limit on the landing speed. Values achieved were $P_{lim}^{ny}$ = 167.3 and $P_{lim}^{vland}$= 395.4.

Calculation of limits with variable c values for relative thickness graph and variable $\lambda$ values for aspect ratio graphs are made. Results are shown below.

These two results stated above are applied into the graphs, limiting the graphs to lines that correspond with a relative wing thickness of 10%, an aspect ratio of 19.16, a taper ratio of 3 and sweep angle of 0.6. Limiting graphs are shown on Figure 4.

Using this method, the new reduced mass that should be focused on when designing the plane is found, and the results of take-off masses are shown in Table 1.

Table 1

**Minimal mass values of limiting graphs for specified parameters gotten from zero approximation design.**

| PARAMETERS | TAKE-OFF MASS |
|---|---|
| Relative thickness | 3600 kg |
| Aspect ratio | 4100 kg |
| Taper ratio | 4000 kg |
| Sweep angle | 4100 kg |

2.3. How the chosen factors influence on the aircrafts take-off mass

During an aircraft's design, parameters like relative wing thick, aspect ratio, taper ratio and sweep angle have a great effect on the mass outcome of the aircraft because of the wing loading factor. So different values of the design parameters have an increase or decrease effect on the take-off mass.

**3. Conclusion**

Considering the four main parameters, the effect on the take-off mass is as shown below:

- changing the relative wing thickness, it reduced the take-off mass to 3600 kg.
- changing the wings aspect ratio, it reduced the take-off mass to 4100 kg.
- changing the wings taper ratio, it reduced the take-off mass to 4000 kg.
- changing the wing sweep angle, it reduced the take-off mass to 4100 kg.

After taking careful investigative measures, it is obvious that a new reduced take off mass for my aircraft at a value 3600 kg.

Carrying out of investigative procedure is important because it allows the designers to realize where the aircraft has minor weakness so they will be able to adjust, correct or improve it structurally so as the improve the overall characteristics of the aircraft.

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## ПРИНАЛЕЖНІСТЬ ПРОЕКТІВ РЕМОНТІВ І МОДЕРНІЗАЦІЇ СКЛАДНОГО ТЕХНОЛОГІЧНОГО ОБЛАДНАННЯ ДО ПРОЕКТНООРІЄНТОВАНОЇ ДІЯЛЬНОСТІ

В умовах загострення економіко-політичної ситуації в Україні, падінням обсягу вітчизняного виробництва, постійним зростанням державного боргу все більшої актуальності набуває проблема пошуку нових підходів до оновлення національної системи господарювання. Однією з важливих галузей вітчизняної промисловості є машинобудування, яке останнім часом перебуває у скрутному становищі у зв'язку зі значним старінням обладнання та технологій, основна